UTAH SCIENCE

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The killdeer on the cover is shading her young from the hot sun. This is just one example of one kind of bird coping with its environment.

At best, a bird's life isn't as simple as it might seem to the casual observer. Always precarious, and generally short, it is a life devoted to finding food for self and young, and avoiding predators—including man.

Every species of bird that exists today is especially adapted to some particular ecosystem. A mountain chickadee couldn't survive in a mallard's world. The spotted owl is seen only in western coniferous forests. The Baltimore oriole doesn't cross the Rockies. On the other hand, even when a species stays in a given area to which it is well adapted, survival isn't assured. For example, Aleutian Canada geese have almost disappeared from their rugged home land because fur traders introduced blue foxes into the Aleutians in 1838. The bald eagle is on the endangered species list. Peregrine falcons may soon join passenger pigeons as another extinct species.

Why do bird species disappear? Sometimes because their habitat is converted to asphalt and concrete, or a forest is clear cut, or brushland becomes cropland. Sometimes because chemicals or other pollutants destroy a vital food source or affect the birds' own reproductive potentials. In general, birds disappear because they can't adapt to the environments people create.

Perhaps, if we want to continue to enjoy the sight and sound of diverse bird life, we will have to give thought to their welfare as we shape our world (and theirs).

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UTAH SCIENCE

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WIDE HYBRIDIZATION: A RADICAL APPROACH TO GRASS BREEDING

DOUGLAS R. DEWEY

Hybridization is one of the basic tools of plant breeders, and it is an integral part of virtually every breeding program. Merging the gene pools of genetically diverse populations through hybridization figuratively shuffles the genetic deck and provides an alert breeder with an opportunity to select new desirable gene combinations.

Each species forms a more or less independent gene pool, and the breeder is generally restricted to those genes within that species pool. Usually, sufficient genetic variation exists within a species to satisfy the demands of a breeder for disease and insect resistance, quality, productivity, etc. However, if a particular character cannot be found in the species gene pool, the breeder looks to other sources, particularly closely related species.

WIDE HYBRIDIZATION

Wide hybridization, i.e. the crossing of individuals belonging to different species, provides a pipeline between gene pools and allows genes from one species to be fed into another. Specific characters, such as disease resistance, have been successfully transferred from wild relatives to cultivated species by wide hybridization followed by repeated backcrossing and various chromosome manipulations. One such transfer, made by E. R. Sears, involved the incorporation of leaf rust resistance from goatgrass (*Aegilops umbellulata*) to common wheat (*Triticum aestivum*). Similar transfers have been made from wild species to cultivated tomatoes, cotton, and tobacco.

A second and even more radical use of wide hybridization is the synthesis of entirely new species. Hybridization of two species generally gives rise to sterile hybrids. Among animals, the mule is a well known example of hybrid sterility, and this sterility must be overcome before a species-hybrid can establish itself as a new distinct species. On rare occasions fertility restoration in sterile plant hybrids occurs spontaneously; but not until the colchicine technique of chromosome doubling was developed in 1937 could man synthesize new plant species with relative ease.

Man-made species, developed through wide hybridization, offer intriguing plant-breeding possibilities. This approach is fraught with difficulties, but some significant progress has been made. The most widely publicized man-made species is perennial wheat, a wheat (*Triticum*) X wheatgrass (*Agropyron*) derivative. Russian plant breeders have been especially active in the development of perennial wheat, and they claim to have thousands of acres under cultivation. Another synthetic species of genuine promise in *Triticale,* a hybrid developed from crosses of wheat (*Triticum*) X rye (*Secale*). Plant breeders from several countries are currently working to improve the quality and productivity of this new cultivated species.

LOGAN WORK

Wide hybridization is being used extensively in grass investigations at Logan. The central objective of the program is to unravel the genetic, phylogenetic, and taxonomic relations among the wheatgrasses and their relatives, but some applied breeding work is also being done. Over the past 10 years more than 60 interspecific or intergeneric hybrids have been produced among wheatgrass (*Agropyron*), wild-rye (*Elymus*), barley (*Hordeum*), and squirreltail (*Sitanion*) species. Fertility has been introduced into about half of the hybrid combinations through the use of colchicine.

Although the term "hybrid" has become almost synonymous with increased vigor and productivity, only

Figure 1. Different degrees of vigor expressed by induced amphiploids of three wide hybrids. Center row: a highly vigorous hybrid of **Elymus canadensis** X **Agropyron caespitosum.** The two rows to the right show the exceptionally poor vigor of **Agropyron spicatum** X **Agropyron caninum** hybrids. The two rows to the left contain a moderately vigorous hybrid, **Elymus canadensis** X **Agropyron subsecundum.**

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a few wide hybrids are potentially superior to their parent species. Merging widely different genetic complements often results in a physiological disharmony with detrimental effects on growth (figure 1). Considerably less than half of the grass hybrids produced at Logan show any plant-breeding potential. Nevertheless, a few have genuine promise as superior new forage grasses.

SOME RESULTS

Quackgrass (*Agropyron repens*) and crested wheatgrass (*Agropyron desertorum*) are well-known grasses with contrasting reputations. Quackgrass is known as a weed of lawns, ditchbanks, and waste places; whereas crested wheatgrass is the most extensively seeded range grass. Both are introductions from Eurasia. The two species hybridize with relative ease and give rise to leafy productive hybrids that lack the strong spreading habit of quackgrass (figure 2). The F_1 hybrids are highly, but not completely, sterile.

Selection for fertile, vegetatively superior, true-breeding plants in the progeny of these F_1 hybrids appears to be futile. The hybrids give rise to a highly variable population. A few F_2s are highly vigorous plants, but they are invariably sterile. Most F_2s are decidedly inferior to the F_1. Simultaneous selection for vegetative characteristics of the F_1 and improved fertility has for the most part been unsuccessful. Fertility can be achieved in advanced generations by repeated backcrossing to either parent species. Repeated backcrossing, however, naturally leads to a rapid reversion toward the vegetative characteristics of the parents.

Induction of fertility through chromosome doubling is a promising means of achieving fertility while retaining the desirable forage qualities of the F_1. Chromosome numbers of at least 10 quackgrass crested wheatgrass hybrids have been doubled with colchicine. The doubled hybrids (induced amphiploids) are more or less fertile and generally breed true. Several thousand induced amphiploids have been grown on the Evans Experimental Farm where they have been evaluated for fertility and forage characteristics. About 250 of the best plants were placed in a seed-increase plot in the fall of 1969. This increase plot will provide a source of seed for testing and further selection.

MORE TO DO

Although considerable progress has been made in breeding quackgrass-crested wheatgrass hybrids, much remains to be done. Newly synthesized amphiploid hybrids are often cytologically unstable, and their fertility may break down in subsequent generations. As yet, nothing is known of the hybrid's

Figure 2. A productive leafy hybrid of quackgrass X crested wheatgrass. The hybrid lacks the aggressive spreading habit that makes quackgrass such a troublesome weed.

area of adaptation or of its ability to compete with other species under grazing conditions. A number of serious obstacles lie ahead in the development of this new species, but none appear to be insurmountable. With sufficient time and a measure of good fortune, we hope to place a useful new grass in the hands of the farmer and rancher.

Another promising hybrid, closely related to the one just described, comes from a cross between quackgrass and Fairway crested wheatgrass (*Agropyron cristatum*). It differs from the previous hybrid in that its induced amphiploid has fewer chromosomes (56 vs. 70), better seed qualities, and more extensive rhizomes. Our preliminary evaluation indicates that the 56-chromosome amphiploid has a greater breeding potential than its 70-chromosome counterpart. One very serious disadvantage of the quackgrass-Fairway crested wheatgrass hybrid is that the two species are extremely difficult to cross. We have managed to acquire only three hybrids, which is far too few on which to base a breeding program.

Most interspecific and intergeneric hybrids involve species native to the same geographic region; however, hybrids between species indigenous to different continents are not uncommon. One such intercontinental hybrid, thickspike wheatgrass (*Agropyron dasystachyum*) X bearded couchgrass (*Agropyron caninum*) has been produced at Logan and may have some breeding value.

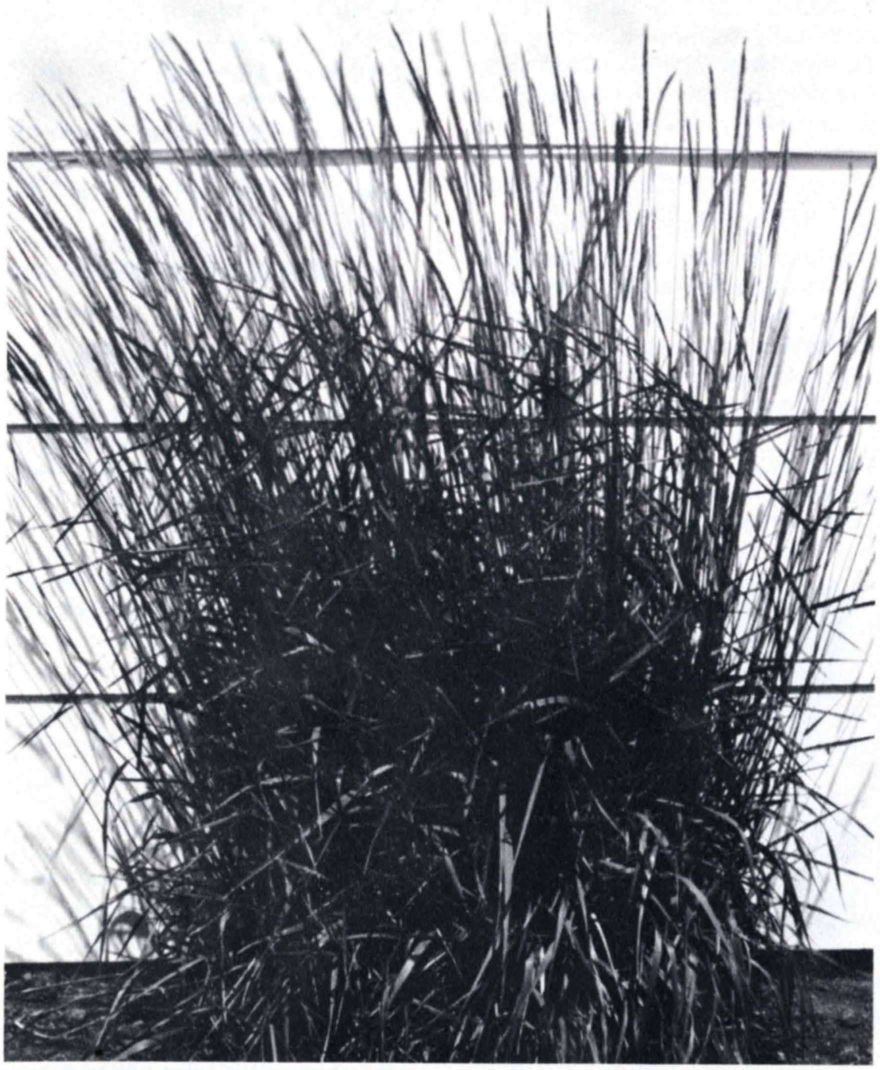

Figure 3. A promising hybrid of thickspike wheatgrass X bearded couchgrass. The hybrid is mildly rhizomatous and has good vigor (lines on the background are spaced 1 foot apart). Resistance to the Banks grass mite is a significant feature of the hybrid.

Thickspike wheatgrass is a stiff-leafed rhizomatous species that forms a significant part of the native grass vegetation in the Intermountain area. It is a drought resistant grass but has relatively poor forage qualities. Bearded couchgrass is a rather luxuriant bunchgrass whose natural distribution ranges from England to Afghanistan. The two species hybridize readily and produce vigorous mildly rhizomatous F_1s with much better forage qualities than those of thickspike wheatgrass (figure 3). Possibly the most important feature of the hybrids is their resistance to the Banks grass mite, which can cause serious damage to several of the commonly seeded range grasses, especially intermediate and pubescent wheatgrass.

The F_1 hybrids of thickspike wheatgrass X bearded couchgrass are highly sterile, but they respond well to chromosome doubling with colchicine. Their induced amphiploids, which contain 56 chromosomes, are highly self-fertile; and no difficulty should be encountered in propagating the hybrid by seed. Approximately 1500 of the amphiploids have been examined, and the best 10 percent were saved and placed in a seed increase plot. Seed from this increase plot will be available for testing in 1970.

The hybrid that probably has the greatest economic potential of any developed at Logan comes from a cross between Standard (*Agropyron desertorum*) X Fairway (*Agropyron cristatum*) crested wheatgrasses. These two forms of crested wheatgrass differ in chromosome number. Standard crested wheatgrass has 28 chromosomes, whereas Fairway has 14. It is commonly believed that tetraploid (28-chromosome) crested wheatgrass was derived from 14-chromosome diploids by natural doubling. Although the two species are closely related, their differing chromosome numbers make crossing very difficult. Barriers to crossing can, however, be removed by bringing the diploid form to the tetraploid level by chromosome doubling.

Several Fairway crested wheatgrass plants were artificially doubled with colchicine in 1960. The induced tetraploids were originally the object of cytological investigations, and the breeding work was an unexpected outgrowth of the more basic studies. Hybrids between the induced and natural-tetraploids were considerably more vigorous than either parent. Inasmuch as the hybrids were fertile, no further manipulation of the chromosome complement was necessary. Fifteen of the most leafy and vigorous hybrids were placed in a seed increase plot in 1965, and several yield trials have been established since then.

The crested wheatgrass hybrids have been outstanding in preliminary comparisons with the most commonly used commercial varieties including Fairway, Nordan, Siberian, and Summit. One outstanding feature of the hybrids is their ability to establish themselves rapidly and produce considerable growth their first season in the field. In a strain trial seeded in the spring of 1968 on the Evans Experimental Farm near Logan, the hybrids averaged 133, 98, 80, and 45 percent more forage in the establishment year than Siberian, Fairway, Nordan, and Summit, respectively. Yield differences were not so great the following year; nevertheless, the hybrids continued their yield superiority over the commercial strains (figure 4).

Other strain trials were established in 1969 at Blue Creek, Utah; Knoll Creek, Nevada; Aberdeen, Idaho; and Tetonia, Idaho.[1] The exceptionally strong seedling vigor of the hybrids was noted in each trial. Considerably more data are needed to adequately evaluate the hybrids; however, prospects for development of superior hybrid strains of crested wheatgrass look good.

Although some of our preliminary breeding results are very encouraging, the practicality of a wide hybridization approach to grass breeding is still open to question. Most of our efforts to date have been centered around the problem of developing fertile true-breeding hybrid populations. Some unanswered questions remain with respect to fertility and stability in advanced hybrid generations, yet we feel confident that obstacles of this nature can be overcome. Persistance and patience will be required to achieve practical results from a wide hybridization program. Perennial grass breeding is inherently slow when compared with annual crops such as wheat, and the wide hybridization approach significantly extends the normal breeding interval. The so-called "preliminaries" of obtaining an adequate number of F_1 hybrids, doubling those hybrids with colchicine, and stabilizing the amphiploid population could easily add 5 to 10 years to the breeding program. Can the expected gains from a wide hybridization program offset the additional expenditure of time and money? We think so.

[1] The Nevada and Idaho trials were planted by the staff at the S.C.S. Plant Materials Center, Aberdeen, Idaho.

Figure 4. A strain trial near Logan comparing hybrids of Standard X Fairway crested wheatgrass with commercial varieties. The hybrid is in the two rows toward the left; and Nordan, the most commonly grown commercial variety, is in the two rows toward the right. Note that the hybrid is so vigorous that the space between its two rows is not visible.

WILDLIFE NOTES

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The fisher cat, natural enemy of the porcupine, avoids the latter's quill-studded defense by burrowing up through the snow and attacking its victim from below, where there are no quills.

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A bull elk weighs from 700 to 1,000 pounds and stands as high as 5 feet at the shoulder.

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The home range of a male mink is 5 miles in diameter, whereas the female confines herself to a range of approximately 20 acres.

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Five million eggs insure the survival of but two mature cod fish.

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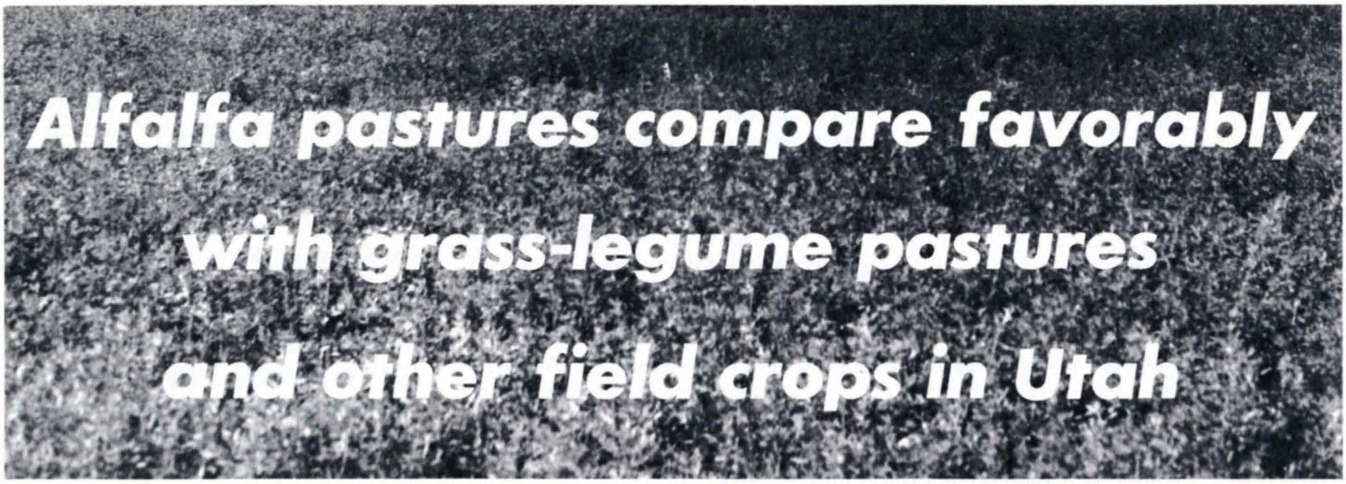
Although marsupials—animals that carry their young in pouches like kangaroos—were once common in North America, the only member of this clan remaining is the opossum.



Alfalfa pastures compare favorably with grass-legume pastures and other field crops in Utah

CLAIR R. ACORD

High carrying capacities of irrigated pastures in Utah has been reported in numerous reports and papers, but the reports usually end with a tone of "if bloat were controlled" or, as Bateman reported in March 1958, "The basic legume mixture with no grasses added yielded nearly twice as much as the basic grass mixture with no legume added."

With the tone of this latter statement and the results reported in the March 1969 issue of *UTAH SCIENCE,* it seemed appropriate to further study grazing of straight alfalfa pastures in comparison to grass-only pastures and grass-legume mixture pastures. Pasture A, located at Palmyra, Utah County, produced 1599 pounds of beef per acre in 1967 and 1736 pounds in 1968. Pasture B located at Heber City, Wasatch County, produced 1369 pounds of beef per acre in 1968. The pastures yielded a gross return of $399.75, $434.00 and $342.25, respectively.

PASTURE A

Pasture A had a total area of 15.7 acres, divided into the following treatments: (1) grass-legume mix (smooth brome—8 pounds per acre and alfalfa—3 pounds per acre or Latar orchard grass—8 pounds per acre and alfalfa—3 pounds per acre) supplemented with 1 pound of grain per head per day (with Poloxalene to control bloat); (2) grass-legume mix supplemented with 4 pounds of grain per head daily (with Poloxalene); and (3) straight alfalfa supplemented with 1 pound of grain per head daily (with Poloxalene).

There were 105 heifers and 6 steers in the total group. The test began April 28. Each animal was individually tagged and weighed every 50 days. The pastures were divided to allow 30 head of cattle in treatment 1, 31 head in treatment 2, and 50 head in treatment 3. The pastures were divided into sections to allow rotational grazing and the pasture was irrigated every 14 to 21 days, depending on water availability.

The grain was fed in a pellet form, made up as follows (for 1 pound grain per animal per day):

Grain pellet
per 2400 pounds*

100 pounds	Poloxalene
200 pounds	molasses
500 pounds	wheat bran
500 pounds	beet pulp
1100 pounds	barley
25 pounds	salt

*25 pounds allowed for shrinkage

Results of the respective treatments are shown in table 1.

The average daily gains of the calves are not excessive nor have

Table 1. Pasture A — gains of cattle over 150 days on three treatments — 1969

50-day periods	4/28-6/17	6/18-8/6	8/7-9/26	Full period
		pounds		
Alf-grass + 1 lb grain/head/day	1.16	0.88	1.46	1.17
Alf-grass + 4 lbs grain/head/day	1.25	1.34	1.86	1.57
Alf + 1 lb grain/head/day	1.52	1.22	1.66	1.50

NOTE: The author acknowledges and expresses thanks to (1) Smith Kline and French Laboratories and Dr. C. R. Miller of Philadelphia, Pennsylvania for furnishing the grain, tags, and poloxalene for the study; (2) Hess & Clark of Ashland, Ohio, for furnishing diethylstilbesterol implants; (3) Elance Products Co. of Greenfield, Indiana, for furnishing the Estrostat; and (4) Paul Daniels, County Agent, Marion Sorenson, and Lloyd Lawton, for their help in furnishing cattle, pastures, and weighing the cattle.

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Table 2. Results of estrostat and diethylstilbesterol treatment

Item	Control	Treatment: 2½ cc estrostat every 50 days heifer	Treatment: 2½ cc estrostat every 50 days/heifer + 15 mg DES
Number heifers	28	45	32
Total lbs gained	5329	9639	7019
Avg lbs gained/ heifer	190.2	219	219
Difference – lbs/ heifer	0	29	29
Percent increase over control		11.5	11.5

Table 3. Summary of pasture A production — 1969

Item	Treatment 1 alf & grass + 1 lb grain	Treatment 2 alf & grass + 4 lbs grain	Treatment 3 alf + 1 lb grain
Total cattle	30	31	50
Total acreage	4.35	4.35	7.0
Avg cattle/acre	6.9	7.1	7.1
Total grazing days	150	150	150
Avg initial wt (lbs)	529	538	523
Avg final wt (lbs)	704	771	748
Avg total gain/animal (lbs)	175	236	225
Avg daily gain/animal (lbs)	1.16	1.56	1.50
Total lbs beef	5,255.0	7,330.0	11,257.0
Total lbs beef/acre	1,208.0	1,685.0	1,608.0
Gross return/acre @ 25c lb	$ 302.00	$ 421.25	$ 402.00

Table 4. Summary of expenses for pasture A — 1969 (calculated on a per-acre basis)

Item	Treatment 1 alf & grass + 1 lb grain	Treatment 2 alf & grass + 4 lbs grain	Treatment 3 alf + 1 lb grain
Interest on investment* @ 6%, real estate & water taxes	$ 80.25	$ 80.25	$ 80.25
Labor @ $2.00/hour	30.15	30.73	30.73
Depreciation, fences corrals	12.00	12.00	12.00
Fertilizer & seed bed preparation	12.33	12.33	12.33
Ins. dipping, interest on cattle, vet bill, grain cost	99.84	198.59	102.74
Total expense	$234.57	$333.90	$238.05

* Interest on investment calculated on an acre value @ $1,000.00 1 acre @ 6%

Table 5. Net profit/loss/acre — pasture A — 1969

Item	Treatment 1	Treatment 2	Treatment 3
Gross return/acre (table 3)	$302.00	$421.25	$402.00
Total expense/acre (table 4)	234.57	333.00	238.05
Net profit or loss/acre	+ $ 67.43	+ $ 87.35	+ $163.95

they been any year. With intensive grazing, however, good production is obtained when total pounds of beef per acre and gross return per acre are considered.

The 105 heifers also were treated as follows: 45 with Estrostat, 2½ cc every 50 days; 32 with Estrostat, 2½ cc every 50 days plus a 15-mg implant of diethylstilbesterol; and 28 were controls. These heifers were divided proportionately between the three treatments and the results are reported in table 2. The treatments of Estrostat and Estrostat plus one 15-mg implant per heifer of diethylstilbesterol gave the same results—a 11.5 percent increase over the controls. All in the control group were tagged with a special blue tag, and all heifers were checked twice daily for estrus. The control group showed regular estrus throughout the summer. Only two Estrostat-treated heifers were found in estrus during the summer.

A summary of pasture A production for 1969 is shown in table 3. Note that alfalfa alone produced 1,608 pounds of beef per acre as compared to 1,208 pounds of beef from an alfalfa-grass mix or 400 pounds more beef per acre under comparable conditions. This was a 33 percent increase in beef production per acre from grazing straight alfalfa pasture. For the third year no cattle were lost from bloat.

The question that arises in the minds of most farmers and ranchers is: What is the net return per acre after expenses? With analysis of the 1969 expenses for pasture A, tables 4 and 5 were constructed. The net return for treatment 1 is $67.43 per acre; treatment 2 is $87.35 per acre and treatment 3 is $163.95 per acre.

In calculating net return, the results would suggest alfalfa can be pastured as a profit superior to the grass-alfalfa pasture mix under the same circumstances.

PASTURE B

Pasture B was divided into four treatments with 25 steers per treatment. The treatments were: (1) grass only plus 1 pound grain; (2) grass and alfalfa plus 1 pound grain; (3) alfalfa plus 1 pound grain; and (4) alfalfa plus 4 pounds grain. (All grain was fed twice daily and all treatments were fed Poloxalene to control bloat.) The pastures were rotationally grazed except treatment 1 (grass only plus 1 pound grain), and this group had freen access to the pastures for the 123 days. One-third of the steers were implanted with 15 mg diethylstilbesterol, one-third with 30 mg diethylstilbesterol and one-third used as a control — reported in table 6.

In 1968 the results with the same experiment on pasture B gave a 10.6 and 21.8 percent increase over the controls when treated with 15 mg and 30 mg of stilbesterol. In 1969 the 15 mg treatment gave a 14 percent increase over the control, but only a 6 percent increase was obtained when the 30 mg implant was used.

The results of the pasture gains on pasture B followed the same pattern as pasture A — decreased gains during warm weather. The results of these treatments on pasture B are reported in table 7.

Where the steers were allowed free access to a grass-only pasture (improved grasses), the alfalfa pasture produced 481 pounds more beef per acre and the grass and legume pasture produced 190 pounds more beef per acre under similar conditions.

The expenses incurred in 1969 on the respective pasture treatments of pasture B are reported in tables 8 and 9. The grass-only pasture, treatment 1, brought a net loss per acre of $27.65 while treatment 3 (alfalfa) returned a net profit of $85.48. Again, as in pasture A, the alfalfa lot of pasture B gave the greatest net return per acre.

Table 6. Average increase in gains and dollar value for 123-day period using diethylstilbesterol implants for 100 steers (25 controls) grazing irrigated pasture B

Item	Control	Treatment 15 mg	Treatment 30 mg
Avg lbs gained/steer	238	242	234
Avg daily gain/steer (lbs)	1.85	1.97	1.90
Percent increase over control		6.4	2.7
Avg gain over control/steer (lbs)		14.0	6.0
Dollar value over control @ 25c lb/steer		$ 3.50	$ 1.50

Table 7. Summary of pasture B production study — 1969

Item	Treatment 1 grass + 1 lb grain	Treatment 2 alf-grass + 1 lb grain	Treatment 3 alfalfa + 1 lb grain	Treatment 4 alfalfa + 4 lb grain
Total cattle	25	25	25	25
Total acreage	8.6	6.8	5.25	5.0
Avg cattle/acre	2.9	3.7	4.8	5.0
Total grazing days	123	123	123	123
Avg initial wt (lbs)	530	512	502	524
Avg final wt (lbs)	757	759	771	785
Avg total gain/ animal (lbs)	227	247	270	261
Avg daily gain/ animal (lbs)	1.85	2.0	2.19	2.12
Total lbs beef	5,675	5,782	5,989	6,509
Total lbs beef/acre	660	850	1,141	1,302
Gross return/acre @ 25c lb	$ 165.00	$ 222.50	$ 285.25	$ 325.50

Table 8. Summary of expenses for pasture B — 1969 (calculated on a per acre basis)

Item	Treatment 1 grass + 1 lb grain	Treatment 2 alf-grass + 1 lb grain	Treatment 3 alfalfa + 1 lb grain	Treatment 4 alfalfa + 4 lb grain
Interest on investment* water & real estate taxes	$ 54.67	$ 54.67	$ 54.67	$ 54.67
Labor @ $2.00/hour	42.00	42.00	42.00	42.00
Depreciation, fences corrals	23.20	23.20	23.20	23.20
Fertilizer & seed bed preparation	7.50	7.50	7.50	7.50
Ins, spray, interest** on cattle, vet bill, grain mileage	65.28	68.28	72.40	128.20
Total Expense	$192.65	$195.65	$199.77	$225.57

* Interest on investment calculated on an acre value @ $800.00/acre @ 6%

** Mileage charged on a/acre basis @ 10 cents/mile for daily travel to and from farm

Table 9. Net profit/loss/acre — pasture B — 1969

Item	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Gross return/acre (table 7)	$165.00	$222.50	$285.25	$325.50
Total expenses/acre (table 8)	192.65	195.65	199.77	255.57
Net profit or loss/acre	— $ 27.65	+ $ 26.85	+ $ 85.48	+ $ 69.93

A major question arising in the minds of farmers and ranchers is: "Is grazing beef cattle on alfalfa pastures comparable in return to producing other crops in Utah?" Actually, each individual may answer that question by applying the expenses and receipts to their own production in a manner similar to the present study. In the opinion of the writer, returns per acre from grazing beef on good irrigated pastures does compete very favorably with Utah field crops.

SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

During the summer of 1969, two different improved, irrigated pastures were grazed intensively under a rotation plan. The summaries are reported in tables 3 and 7. The comparative studies between the treatments of each pasture suggests that more pounds of beef per acre can be produced by rotational grazing of straight alfalfa than by rotational grazing of alfalfa-grass mixture. More net return per acre is available from straight alfalfa than from the other pasture mixtures. Even the grass-alfalfa pastures, properly managed, can compete favorably with field crops in Utah as a source of income to Utah farmers and ranchers. In the opinion of the writer, it is not financially practical to feed 4 pounds of grain each day to catle on lush pastures. One pound of grain can be profitably fed, however.

It may be concluded that properly managed pastures can bring a net return of $25.00 to $164.00 per acre, including credit for labor. To obtain these returns, pastures should be: (1) grazed in rotation; (2) grazed intensively for 4 to 5 days; (3) allowed to rest and grow for 25 to 30 days before grazing again; and (4) irrigated according to the plants' needs, usually every 14 to 21 days.

To obtain high beef production from irrigated pasture, use: (1) pastures with predominant or straight stands of alfalfa; (2) use diethylstilbesterol for steers and estrostat, or a similar product, to control heat and improve weight gains in heifers; and (3) use a bloat preventative treatment, such as Poloxalene. The cattle, if fed a top dressing of Poloxalene with grain must be fed half the mixture every 12 hours to properly control bloat.

The use of high yielding, well adapted forage species will allow a good production of beef per acre when good management is applied.

Two new barley varieties for Utah

WADE G. DEWEY

Seed of two new spring barleys will be released in limited quantities to barley growers in Utah this spring. The varieties, named Woodvale and Bonneville 70, were developed at Logan through the cooperative efforts of the Utah Agricultural Experiment Station and the United States Department of Agriculture.

WOODVALE

Woodvale is a shorter, earlier-maturing selection from Vale, a variety which also was developed at the Utah Agricultural Experiment Station. The selection was made in 1964 from 200 headrows of Vale which had been sent to Yuma, Arizona for a winter increase. It was observed that several of the headrows (short rows derived from individual heads) were several inches shorter than the rest and matured approximately 1 week earlier.

Since both of these characteristics —earlier maturity and shorter straw —are desirable in an irrigated barley variety, these variant rows were harvested and composited for further testing. Height and heading data for Woodvale and several other varieties presently grown in the Intermountain area are shown in table 1.

Woodvale is not as short as the variety Steveland, nor as early maturing as Steveland or Gem. However, it averages approximately 5 days earlier and 3 to 5 inches shorter than Vale and Bonneville, the varieties with which it will compete. Its shorter straw gives Woodvale an advantage over Bonneville and Vale with regard to lodging. Although not as short as Steveland, Woodvale has much stiffer straw and, consequently, lodges less.

During its testing period, Woodvale has yielded well in relation to the standard varieties being grown in this area (table 2).

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Table 1. Height and heading data for several barley varieties grown at the Greenville Experimental Farm, Logan, Utah, 1966-1969

Variety	1966	1967	1968	1969	4 year avg
Height (inches):					
Trebi	32	36	40	29	34
Bonneville	34	36	42	33	36
Gem	32	36	38	25	33
Steveland	21	27	33	19	25
Vale	34	32	36	29	33
Woodvale	31	29	34	25	30
Heading date:					
Trebi	6-17	7-3	6-20	6-12	6-21
Bonneville	6-21	7-8	6-27	6-20	6-27
Gem	6-11	6-26	6-14	6-5	6-14
Steveland	6-12	7-3	6-16	6-7	6-17
Vale	6-21	7-10	6-28	6-19	6-27
Woodvale	6-16	7-5	6-22	6-14	6-22

Table 2. Comparative yields of Woodvale and a number of standard barley varieties at several locations in Utah for the period 1966-1969

	Trebi	Bonneville	Gem	Steveland	Vale	Woodvale
			bushels per acre			
1966:						
Logan	84.8	86.2	81.5	81.6	81.4	90.7
1967:						
Logan	96.7	111.4	105.7	110.1	113.9	116.5
Farmington	79.4	75.5	99.4	92.5	77.8	92.4
5-county trials	90.7	103.2	99.2	109.2	106.2	111.5
1968:						
Logan	103.6	132.2	121.1	115.3	127.2	148.5
Farmington	112.6	129.0	124.4	128.8	130.2	140.1
3-county trials	85.3	94.7	91.0	98.3	104.3	112.0
1969:						
Logan	108.7	109.5	82.3	103.3	110.3	109.9
Farmington	87.6	96.4	75.0	97.9	104.6	103.9
15-nursery average	92.2	102.6	97.2	104.7	106.0	113.0

Loose smut is probably the most serious barley disease in Utah at the present time. Woodvale possesses excellent resistance to the races of loose smut found in this area.

THRESHABILITY

Woodvale is somewhat deficient in threshability, and this will limit its popularity to some extent. The beards are tough, and unless threshing conditions are good, i.e. the crop fully mature and the weather dry, it is difficult to obtain a clean separation of beard and kernel. It is no harder to thresh, however, than Vale from which it was selected, and Vale is popular with growers in several important barley-growing areas of Oregon, Idaho, Utah, and Nevada. Since Vale is already widely grown and — notwithstanding its poor threshability — is generally well thought of, there should be a place for this earlier, shorter selection.

Woodvale is a 6-row, smooth-awned variety with a compact head. During the early heading stage it can be distinguished from other varieties by its glossy head, as contrasted to the normal dull green heads of most varieties at this growth stage. It is a feed barley and performs best on medium-to-heavy soil under conditions of good moisture and fertility. It is not adapted to dryland areas. Approximately 20 acres of registered seed was produced in 1969. Most of this seed will go to certified seed growers for further increase in 1970. By 1971, seed of Woodvale should be generally available.

The name Woodvale was selected, since it draws attention to its relationship to the variety Vale and to the late Dr. R. W. Woodward, who played an important role in its development.

BONNEVILLE 70

Bonneville 70 is an improved-threshing strain of the variety Bonneville. Bonneville has been one of the leading varieties in irrigated regions of the Intermountain area and the Pacific Northwest; but its popularity has subsided somewhat in recent years, primarily because of its poor threshability.

In 1952 Dr. R. W. Woodward, a USDA cereals breeder stationed at Utah State University, sent seed of Bonneville to the Brookhaven National Laboratory at Long Island, New York, for irradiation in the hope of inducing a mutation for brittle awns. Out of several thousand X_2 plants (second generation progeny from the irradiated seed) he isolated a number of brittle awn types which threshed much better than regular Bonneville, but which were otherwise morphologically indistinguishable from it. One of these lines gave rise to the variety Bonneville 70.

UNDER FIELD CONDITIONS

Under field conditions, Bonneville 70 frequently shows more loose

(Continued on Page 15)

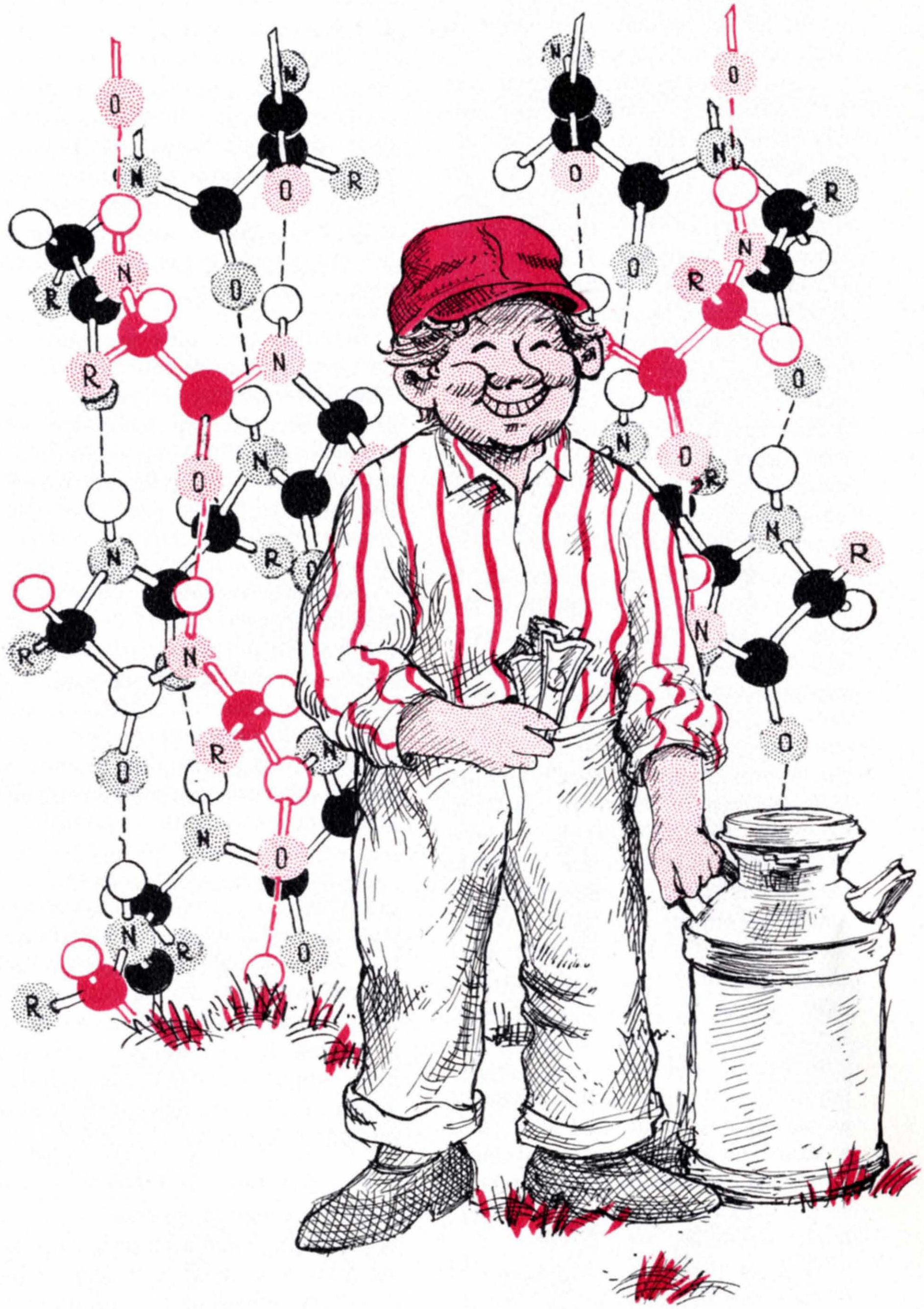
Table 3. Comparative yields of Bonneville and Bonneville 70 for the period 1966-1969

	Bonneville	Bonneville 70
	bushels per acre	
1966:		
Logan	86.2	85.9
1967:		
Logan	111.4	117.4
Farmington	75.5	78.4
5-county trials	103.2	103.0
1968:		
Logan	132.2	123.5
Farmington	129.0	122.2
1969:		
Logan	109.5	110.0
Farmington	96.4	101.0
12-nursery average	104.7	104.5

Table 4. Comparison of Bonneville and Bonneville 70 for various agronomic characteristics

	1966	1967		1968		1969		
	Logan	Logan	Farmington	Logan	Farmington	Logan	Farmington	Avg
Height (inches):								
Bonneville	34	36	39	42	43	33	27	36.3
Bonneville 70	35	36	39	41	44	33	27	36.4
Heading date:								
Bonneville	6-21	7-8		6-27		6-20		
Bonneville 70	6-21	7-8		6-27		6-20		
Test weight (lbs/bu):								
Bonneville	48.5	51.0		50.5	50.0	50.0	51.0	50.2
Bonneville 70	49.0	51.0		49.0	51.0	49.0	52.0	50.2
Threshability rating:								
Bonneville	Fair	Poor	Fair	Good	Fair	Fair	Fair	
Bonneville 70	Excellent	Good	Good	Good	Good	Good	Good	

PROTEIN PAYMENTS FOR MILK PRODUCERS– TREND FOR THE FUTURE?



ALLEN LeBARON

Last September, a Utah Cooperative, Hi-Land Dairy introduced a system of bonus payments to its producer members in cases where milk of above average protein content is delivered. Apparently Hi-Land is only the second handler in the whole country to employ such a scheme. The first was the Golden Guernsey Dairy Cooperative of Milwaukee, whose bonus system has been in effect since 1962. Two other handlers have elected to by-pass bonus payments and move directly to a method of paying for producer milk on the basis of fat and protein content, with little or no allowance for weight of the water portion (an adjustment can be made for minerals and lactose). These handlers are Glacier Mountain Cheese, Galatin Gateway, Montana, and Salmon Valley Cheese, Salmon, Idaho.

The Salmon Valley handler's plan offers help to producers who wish to begin selection of replacement animals on the basis of their protein production potential. This upgrading is obviously important to any cheese plant operation because of the connection between protein content of milk and ultimate cheese yields.

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ALLEN LEBARON is a Professor in the Department of Agricultural Economics.

Other handlers, principally cheese makers, are also reported to be investigating the suitability of introducing protein payments or bonuses to their producers. Among those in the United States are a South Dakota firm, Winger Cheese Co., and two well-known Utah manufacturers, Nelson-Ricks Creamery and Cache Valley Dairy.

The basis for any plan to introduce protein payments must rest upon a quick, accurate, and inexpensive test. At least two large, electronic machines are now, or soon will be, available to give rapid constituent analyses of fluid milk, but they suffer from a technical drawback: they are not too suitable for testing finished products. Thus, they are not readily adapted to the need to link purchased protein in milk with its final resting place in various products. If a plant manager decides to single out protein (or fat, or both) for payments, he needs to be able to account for its ultimate disposition in high or low valued products.

Thus far only what is known as a "dye-binding" system for measuring protein seems to meet this accounting need. Until early 1967, no particular dye or technique had general approval of the American Association of Analytical Chemists (Golden Guernsey had made use of a nonapproved dye test prior to this time because they needed only a test on milk and not on finished products). The approved test gives excellent results on finished products and therefore seems to remove the main technical barrier to widespread adoption of systems of direct protein payments to dairy farmers.[1]

Despite the lack of large scale adoption of protein payments in the interval since test approval, very real pressures are building for such action. At least 14 federal marketing areas have already purchased dye-test equipment. These areas will use the approved test to check handler milk-use reports that are made to producer payment pools. Federal Order Administrators are confident that the test is accurate enough to detect any inconsistencies in handler reconciliation of skim solids purchases with final uses. Manufacturers may have to adopt exactly the same system to avoid difficult squabbles with federal authorities over use reports. Once the dye-test is common as an inplant accounting tool, it is a minor technical step to producer payments for protein. This refers to systems more complex than simple bonus payments.

Of course milk fat will continue to have substantial value, though recent research suggests that price per pound will probably fall should a protein system become widespread.[2] The lessened value of milk fat will be offset by the protein payments. Farm herds producing relatively greater protein, however, will tend to reap special benefit. At present, many pricing formulas are linked to total milk weight. Future payments may simply be for actual pounds of fat and protein delivered to processors.

Breeding programs are likely to shift emphasis to protein production. This will probably be general for all breeds because apparently there is no difference in the protein molecules secreted by different breeds. Dye test results are not affected by breed.

Research programs directed to defining the effects of dairy cattle feeding formulas on efficiency of grain and fodder conversion will have to be intensified. Farmers will need much more information about the costs and practicality of altering milk component relationships by adjusting rations.

At least some of the Dairy Herd Improvement Association computer systems that forecast milk production over the life of an individual animal will have to be revised. In fact, if total milk weight ceases to be a pricing factor, many commonly held opinions about the relative worth of different dairy breeds may be open to question.

It is possible to link levels of producer payments directly to the costs of producing such high protein commodities such as cheese and nonfat powdered milk. As a consequence, it may be found that an item like nonfat powder is worth more than currently assumed. In that case, the cost of producing "filled" milks and certain other imitations would increase. This might reduce considerably the threat of intensified competition from dairy substitutes.

These are just some of the possibilities. But after all, the imminence of a protein payment system has been predicted numerous times since the late 1950s. Such pricing has never materialized before, why get excited now?

Obviously, it took time to perfect a dye that possessed all the technical attributes neecssary for test purposes. But this is only part of the explanation.

Following development of protein-binding techniques using colored dyes a decade ago, descriptive notes and articles appeared in both popular and specialized dairy publications to alert dairy producers of impending pricing changes. In essence, their authors suggested that payments for protein might be a step in the direction of rewarding individual producers for varying amounts of solids-not-fat (SNF). This argument was fairly attractive to dairy farmers because, even in cases where some allowance is made for SNF, it is usually an average percentage regardless of variations in individual shipments.

But handlers were not convinced. In their view, protein payments would have had the same consequences as all systems concerned with pricing total SNF. These latter plans held (and still hold) little appeal because it is too difficult to make estimates of solids in finished products. There is not much incentive to make payments for components that cannot be accurately accounted for in manufacturing processes.

Certain early dye experiments were traditional in that the goal was to establish the dye-binding capacities of particular product classes as well as of fluid milk. This would have led to one kind of computation for homogenized milk, cottage cheese would require another, and so forth. Manufacturers or regulatory agencies needed to know what was "in" the end product before tests were begun, otherwise the wrong conversion tables would be chosen. But knowledge of content was just what the test was supposed to facilitate! Inplant accounting on this basis was impractical.

[1] Substantial reliance upon dye tests has been the practice in Holland for a number of years. Exactly how the tests are employed in the compensation of producers is not known by the author. There is no evidence that the dye test is used as a manufacturing plant "accounting" tool.

[2] Utah Agricultural Experiment Station Bulletin 473, An Analysis of Protein Accounting and Pricing for Milk and its Products.

Under the new system all finished products are assumed to have the same dye binding capacity as fluid milk. As a result, protein is slightly over-estimated in some products and under-estimated in others. But such errors cancel each other when reconciliation is made with the protein quantities manufacturers purchase from producers.

Recent experiments at Utah State University suggest that a one-conversion-factor accounting system should be accurate within 2 percent. Thus, if the Babcock test is used to account for the cream portion throughout manufacturing processes, and the approved dye-test is used to account for SNF, the movement of all milk purchases into final products can be monitored. It is true that only fat and protein are actually monitored, but they are good indexes to presence of all components.

The dye that has been approved is known as acid orange 12. It binds protein molecules very well and the dye solution can be stored for long periods with little effect on accuracy. A measured amount of dye re-agent is mixed with a small sample of milk. The protein molecules bind with the dye, become enlarged, and can be filtered out of the colored mixture. The quantity of unbound or left over dye is determined by calculating electronically the amount of light it blocks out when viewed through a colorimeter (spectrophotometer). Since the amount of light the initial dye quantity can block is already known, the difference in instrument readings or light intensity must be proportional to the percentage of protein in the milk sample.

Most manufacturing processes have litle effect upon milk protein and therefore do not modify the binding powers of the dye. The main exceptions are milk that has been sterilized or cheese that has been aged. In each of these cases, the protein molecules change by various degrees and this affects the accuracy of the test. However, sterilized milk forms a very small portion of total product output, and tests on fresh cheese are quite precise. In general the error in the dye test is about one-fourth as great as the traditional method for measuring protein (Kjeldahl), which is also slow and expensive. The new dye test for protein is more accurate than the Babcock test for fat. Sixty or more tests per hour may be possible at a cost of less than 15 cents each.

TWO NEW BARLEYS

(Continued from Page 12)

smut than does Bonneville. As is usual with radiation - induced changes, it is seldom that only one character is affected. In the radiation process which created the easier-threshing characteristic, Bonneville's smut resistance apparently was altered also. However, Bonneville 70's susceptibility to loose smut is no greater than that of the widely grown varieties, Gem and Steveland. With the recent development of an effective chemical control for loose smut (certain oxathiin fungicides), loose smut can be held in check even in susceptible varieties.

Bonneville 70 is virtually identical to Bonneville in yield, maturity, and in other agronomic characteristics. Tables 3 and 4 summarize the performance of the two varieties over several years and locations.

Bonneville 70 is a white-kerneled, six-row, smooth-awned spring barley. It is high-yielding, has stiff straw and is of late maturity. It is recommended for irrigated sections of the Intermountain area with fertile, medium-to-heavy soils.

Approximately 60 bushels of foundation seed were grown in 1969. This will be increased by certified seed growers in 1970. Commercial seed should be available by 1971.

WET IS NOT ENOUGH

LOIS M. COX

ECOLOGY—A PHILOSOPHY IN ACTION

PART 5

As an attitude towards nature and all living things, ecology provides a realistic perspective for the future. It is concerned with every participant in a given environment, from weather phenomena to soil organisms, and with the relationships that develop from their interactions. Ecology therefore embraces many sciences.

The diverse ecology-oriented research at USU is unified by a shared recognition of the interdependence that characterizes the natural world—including man. This series of articles illustrates that interdependence and shows how the ecological attitude benefits each of us.

We had to see most of our major lakes and rivers either clogged with sewage-fed algae or scoured of life by chemical pollutants—but now we know. Access to ample clean water is not a God-given right.

To support life, we need pure, "healthy" water—water that is more than just wet. But that kind of water is not going to be available simply because we *need* it. We will have enough good quality water only if we learn to reverse present trends. And that difficult goal is not likely to be achieved until we understand the ecology of water—wherever and however it occurs.

RESEARCH AS A TOOL

Scientists at USU have been doing research on water ever since the school was founded. Beginning with an emphasis on irrigation technology, the program has grown to include such topics as weather modification and statewide water management criteria.

Within the past 3 years, USU's water research program has incorporated two projects that have special ecological significance. One is being carried out on Amchitka Island in the Aleutians. The other is based in Logan. Both are producing results useful to people in and out of Utah who recognize the immensity of our evolving water problems.

WHY AMCHITKA?

Amchitka is one of the Aleutian Islands off the coast of Alaska that have been designated as a wildlife refuge. Amchitka itself was further designated by the Atomic Energy Commission as suitable for testing nuclear explosions.

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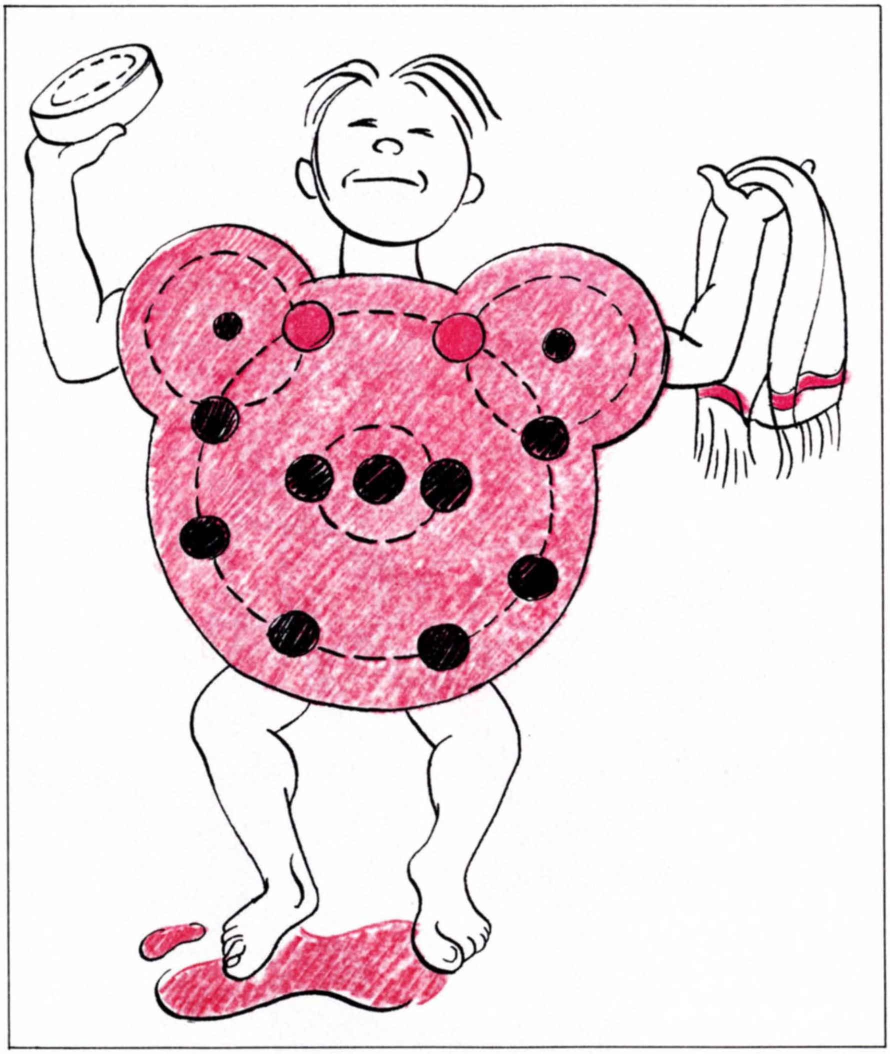

Figure 1. Clean, healthy water is only going to be available if we learn to reverse present trends of use.

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The AEC's use of the island in 1965 was severely criticized because lack of preliminary evaluations made it impossible to adequately determine the effects of the nuclear blast on the island's ecology. Spurred by the criticism, the AEC decided to sponsor before and after studies in conjunction with their next detonation.

Two USU scientists were assigned the responsibility for defining the freshwater vertebrate and invertebrate ecology of the island. In 1967 they began to establish basic baseline data about freshwater ecology as it then existed on Amchitka. The natural state of the island had already been changed by construction activity, human habitation, waste disposal, etc., so the original ecology could not be defined. But by cataloguing the 1967 situation, they hoped to be able to identify any specific effects of the next blast.

By the time of the October 2, 1969, one-megaton, underground detonation, the USU scientists, along with others from other institutions, had developed a satisfactory description of the area's total ecology. Within that total, the freshwater lakes and streams were found to have an ecology quite similar in type to that of waters in high mountain areas in the western states. The main difference is that the Amchitka ecology is much less complex and therefore easier to study.

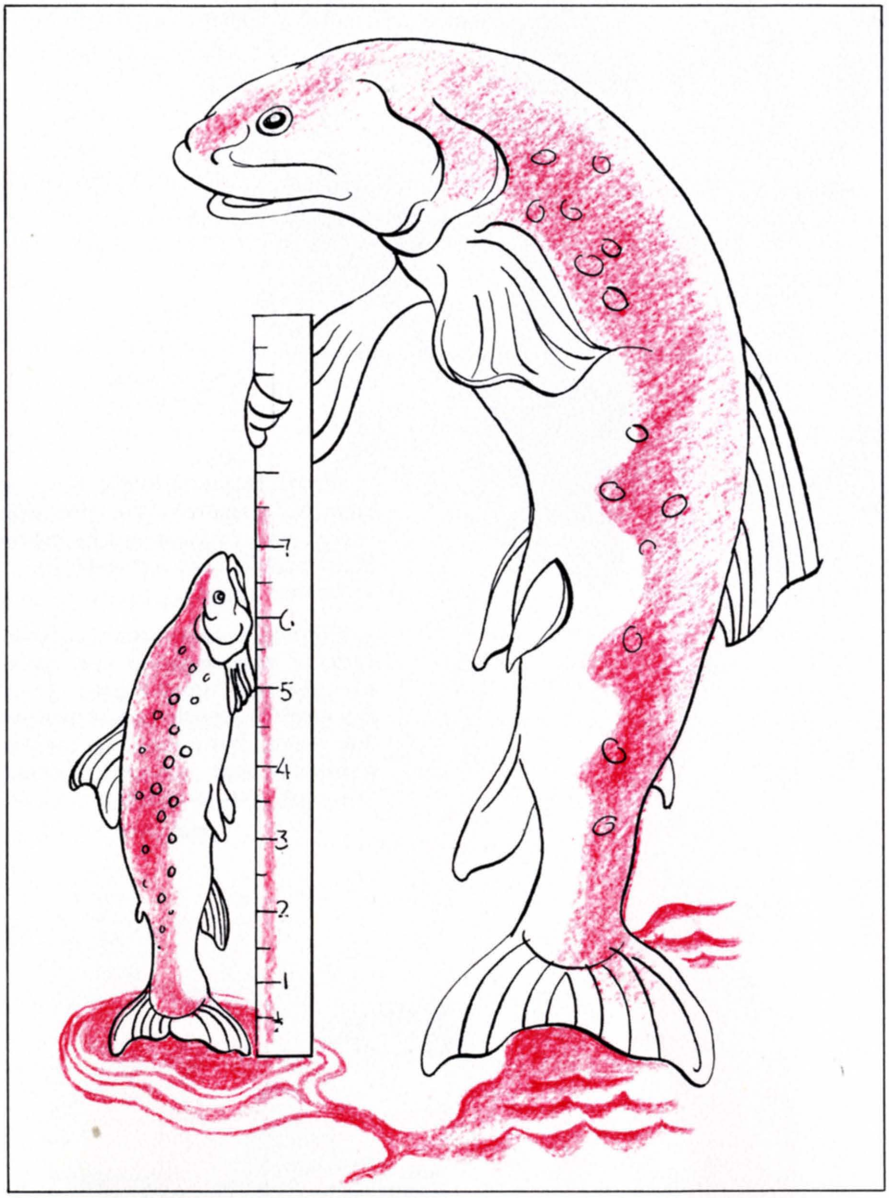


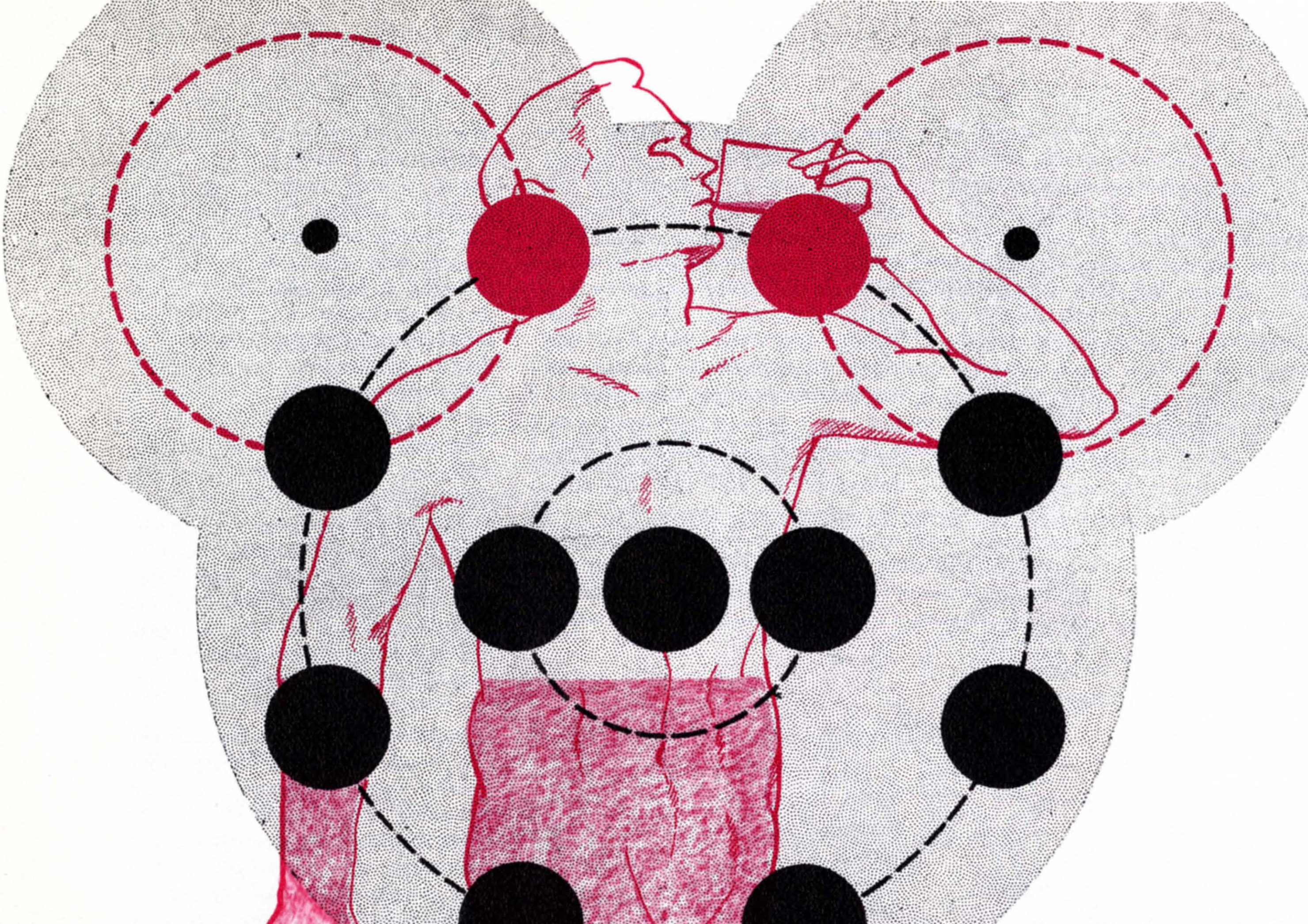
Figure 2. A Dolly Varden that spends its entire life in an Amchitka lake or stream will be only about 7 inches long at 5 or 6 years of age. One that has gone to sea may measure 18 inches or more at the same age.

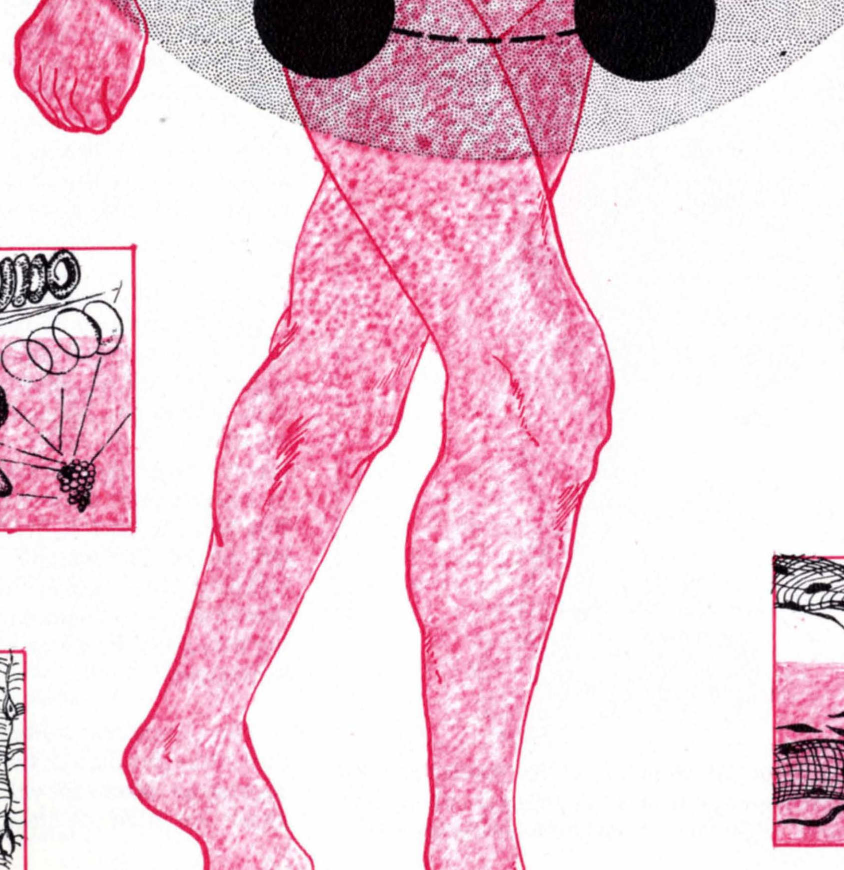
Instead of dozens of fish species, Amchitka streams and lakes are populated primarily by only two. The Dolly Varden resembles a brook trout, and the three-spined stickleback occupies about the same position in the Amchitka food chain as the minnow does in Utah streams. The invertebrate and plant populations are equally limited.

But despite the overt simplicity of the system, the USU scientists rather quickly found themselves with an intriguing mystery. Some of the Dolly Varden migrate to the ocean —precisely what determines which ones stay home is still unknown. It is also unknown whether the same fish make the trip each year. What *is* known is that a Dolly Varden that spends its entire life in an Amchitka lake or stream will be only about 7 inches long at 5 or 6 years of age. One that has gone to sea may measure 18 inches or more at the same age.

If detailed descriptions of the Amchitka area can be recorded over several years, they could provide insights into the likely effects of human activity on the ecology of our western, high-mountain streams and lakes. Eventually, the scientists hope to convert their data into equations that can be used to predict ecological events. For example, how much camping "use" can a high-country meadow absorb without deteriorating into a less attractive plant-animal ecosystem?

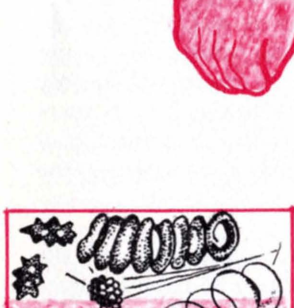
The Amchitka studies may also provide valid bases for predicting ecological effects if nuclear explosions are used to gain access to

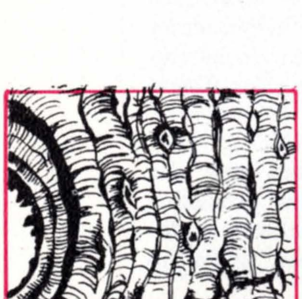


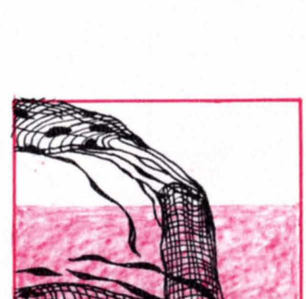


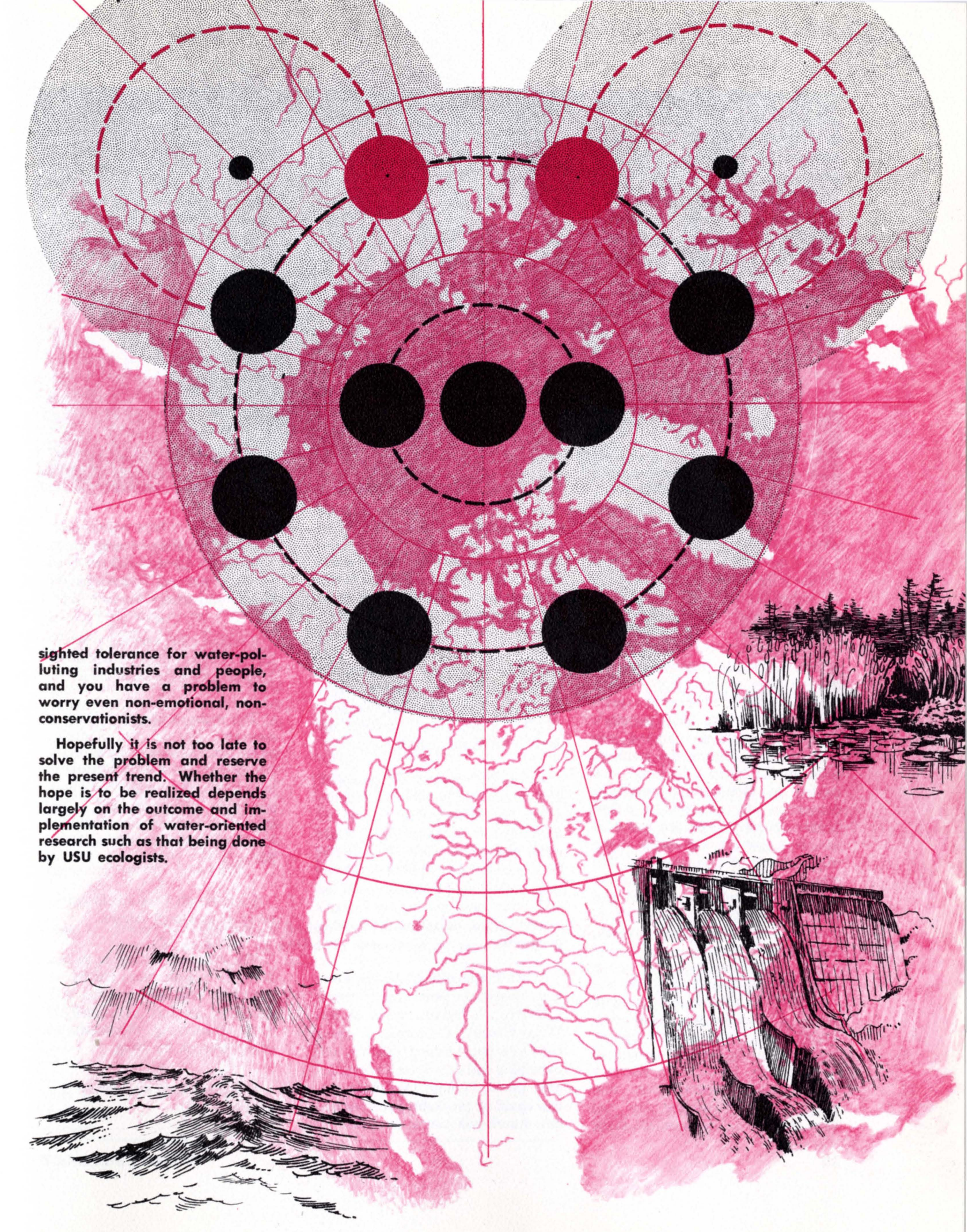
Water is deceptively easy to take for granted. Yet this universal and indispensable ingredient of life does not exist in an unlimited supply.

Nature's continuous, closed cycle of regeneration can never provide any "new" water. So as the world's population increases, we have less and less water available per person. Couple this with a protracted, short-









sighted tolerance for water-polluting industries and people, and you have a problem to worry even non-emotional, non-conservationists.

Hopefully it is not too late to solve the problem and reserve the present trend. Whether the hope is to be realized depends largely on the outcome and implementation of water-oriented research such as that being done by USU ecologists.

stores of natural gas. Nuclear force is being considered as a tool in extracting oil from oil shale. The Amchitka results should allow us to pre-evaluate probable side effects in such cases, too.

So the answer to "Why Amchitka?" is that it was available and funded for study. And, as with so much research, the geographic location of the project doesn't rigidly restrict possible applications of the results.

WATER AS A WASTEBASKET

The Logan-based research is even more obviously practical than the Amchitka work. Throughout the U.S. we are pouring 600 percent more wastes into our fixed supply of water than we were in 1900. This load has totally overwhelmed the capacities of many of our rivers and lakes—with the prime example being Lake Erie. But no part of the country has a monopoly on dead and dying water. So the search for efficient ways to convert wastes into assets is widespread.

The USU scientists working on this problem are using the Logan sewage system as a source of experimental data. Before 1967 the city's sewer system simply emptied into open ditches. During the summer, some of the untreated sewage was used as irrigation water, a potentially dangerous practice from a public health viewpoint. The rest was held in a large pond where much of the organic material was converted into phosphates and nitrates. During the winter, the pond was emptied and incoming sewage was discharged directly into the Logan River, again, a hazardous situation.

Between 1965 and 1967, the scientists made bacteria counts, took plant and fish censuses, and estimated insect populations at various locations during different seasons of the year. By 1967, when the new lagoon sewage system went into effect, extensive baseline data had been developed. The scientists knew where and when certain bacteria and invertebrates thrived — and died — and they had indications of how fish responded to these changes.

Over the past 2 years, continued sampling has provided information that is being used to evaluate the relative efficiency of new versus old. The general conclusion is that the Logan lagoon system will be exceedingly efficient as more is learned about "managing" the ponds. The data indicates that by keeping the inflow confined for specific times in specific ponds, the ultimate outflow will be stabilized all year at a low bacteria content. In fact, during the summer of 1968, bacteria counts at the last outlet were well within the range of comparable counts made near a Bear Lake swimming beach.

The next step is to convert the data into equations that can be used to predict what will happen over time and with changing circumstances in lagoon sewage systems, whether in Utah or any other state. As the equations are built into a "computerized model," it should even be possible to predict how bodies of water, such as Bear Lake, will change if their pollution load is increased. This might help us keep all the "Bear Lakes" around the country from premature death.

Before the research is terminated, it also may be possible to identify which organisms in the system are most effective in transforming waste water into usable water. If these can be concentrated without affecting their usefulness, perhaps some of the 462 acres now serving as Logan's lagoons could be released for other purposes.

When the quality of the last pond is stabilized, the pond could become a fishery. A lagoon system in San Diego County, California, is being used to support fishing, boating, and swimming and to irrigate a municipal golf course. Perhaps the Logan system could be profitably incorporated into a park-golf course complex.

PARTNERSHIP FOR LIFE

Around the world, people are realizing that water will sustain its own productivity (and their lives) only if it is recognized as a partner, rather than as a servant to be exploited. USU's aquatic ecology research program is designed to help all of us learn to implement that truth as quickly as possible.

WILDLIFE NOTES

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A hungry owlet, if given the opportunity, will consume its weight in food during a 24-hour period.

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The female mayfly lays an average of 4,000 eggs, although some have been known to lay as many as 8,000.

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Upon hatching, young snapping turtles dig themselves out of the sand pit nest formed by the female and forage on their own.

•

German carp average from 10 to 15 pounds in weight and some 20-pounders have been caught.

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The male sandpipiper leads a miserable life; the role of dominance usually enjoyed by males in the animal and bird kingdoms is relegated to the female. She wears the bright plummage and is the aggressive partner in courtship. He builds the nest and incubates the eggs.

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Largemouth bass are found in every state except Alaska.

•

The dragonfly, living as an underwater nymph, dines chiefly on mosquito wrigglers or larva, and continues its diet as a winged adult, consuming thousands of mosquitoes on the wing.

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Sparrows have an average life span of 4 years.

BRIDGER-A NEW HARD RED WINTER WHEAT

WADE G. DEWEY

Foundation seed of a new winter wheat variety was released to seedsmen in the fall of 1969 for commercial increase. The variety, named Bridger,[1] was developed and evaluated cooperatively by the Utah Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture. It is being recommended as a replacement for the variety, Cache, which has for several years been balancing on the edge of the USDA's discount list because of marginal baking quality. Discounted varieties are penalized approximately 20 cents per bushel under the government's price support program.

The cross that eventually resulted in Bridger was made in 1959 between the varieties Delmar and Columbia. Throughout its testing period, Bridger was identified as breeding selection 646-50. The new variety is a bronze-chaffed, bearded wheat which resembles its Columbia parent more than it does Delmar. It is medium in height and has straw which tends to stand better at maturity than Cache; however, it is not as stiff-strawed as Delmar.,

Bridger has a distinctive dark green color during its early vegetative growth. It matures a few days earlier than Cache. The kernels are smaller, shorter, and usually plumper than Delmar.

THE ADVANTAGES

Although the decision to release Bridger was based primarily on its quality superiority over Cache, it offers at least one advantage over each of the varieties presently grown on Utah's drylands. It has better harvesting characteristics than Delmar. Some growers have trouble getting Delmar's stiff straw into the combine, whereas Bridger's limber straw feeds readily into the machine. Delmar also has a brittle head at maturity, and care has to be taken to prevent the loss of broken heads during the harvest operations. Bridger, by contrast, has a tough nonshattering head which rarely breaks up prior to reaching the combine cylinder. Bridger has an advantage in smut resistance over several other

[1] Appreciation is expressed to the following organizations for their cooperation and assistance in the development and testing of this variety: Utah-Idaho Grain Exchange; Pillsbury Mills, Inc.; Colorado Mill and Elevator Co.; Regional Cereal Diseases Research Laboratory; and the Western Wheat Quality Laboratory, Pullman, Washington.

Table 1. Dwarf bunt reactions of Bridger and several other winter wheat varieties grown in an artificially inoculated nursery at Logan.

	Percent Infection			
Variety	1966	1967	1969	3 year avg
Bridger	10	20	35	22
Cache	15	25	30	23
Delmar	15	30	30	25
Itana	90	99	99	96
Itana 65	95	99	99	98
Tendoy	95	99	99	98
Wanser	90	95	99	95

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varieties commonly grown in this area. While it is not highly smut resistant, it possesses the same level of resistance as Cache and Delmar, which is considerably better than that exhibited by the varieties Itana, Itana 65, Tendoy, Wanser, and McCall. A comparison of the smut reactions of Bridger and these other varieties is shown in table 1.

IMPROVED BAKING

Bridger's milling and baking characteristics are similar to those of Delmar and the other improved-quality breadwheats grown in the

(Continued on Page 32)

Table 2. Quality characteristics of Bridger and several other winter wheat varieties

Year, variety and location	Protein (%)	Mixing stability (minutes)	Loaf volume (inches)
1967:			
Bridger (Blue Creek)	12.3	7.4	47.50
Cache (Blue Creek)	13.2	2.5	43.75
Delmar (Blue Creek)	12.4	9.5	49.00
Itana (Blue Creek)	12.3	9.9	47.40
Itana 65 (Blue Creek)	12.7	9.3	48.50
Tendoy (Blue Creek)	12.6	8.0	47.75
Wanser (Blue Creek)	12.2	13.3	48.65
Bridger (County trials)	15.4	10.8	49.00
1968:			
Bridger (Blue Creek)	13.3	11.3	49.00
Cache (Blue Creek)	13.3	3.0	42.50
Delmar (Blue Creek)	13.2	8.4	47.38
Itana (Blue Creek)	12.8	17.6	46.75
Itana 65 (Blue Creek)	13.3	16.9	47.38
Tendoy (Blue Creek)	13.4	11.7	45.75
Wanser (Blue Creek)	12.4	14.3	47.50
Bridger (Pocatello Valley)	13.4	16.5	46.75
Cache (Pocatello Valley)	14.0	3.0	44.25
1969:			
Bridger (Blue Creek)	13.2	8.0	44.40
Cache (Blue Creek)	14.4	5.5	43.25
Delmar (Blue Creek)	12.2	9.6	44.50
Itana (Blue Creek)	12.3	11.3	43.90
Itana 65 (Blue Creek)	12.7	11.2	43.50
Tendoy (Blue Creek)	13.5	13.1	42.60
Wanser (Blue Creek)	11.7	11.3	43.90
Bridger (County trials)	13.3	13.7	47.90
Cache (County trials)	14.2	9.2	45.90
Delmar (County trials)	13.7	23.0	46.10
Wanser (County trials)	12.8	13.0	45.60

Table 3. Test weights of Bridger and several other winter wheat varieties

Variety	1967	1968	1969	3 year avg
		pounds per bushel		
Bridger	62.7	59.0	64.0	61.9
Cache	62.3	59.0	63.3	61.5
Delmar	59.7	56.0	62.7	59.5
Itana	62.5	59.0	64.0	61.8
Itana 65	62.0	58.0	63.5	61.2
Tendoy	61.7	56.5	63.3	60.5
Wanser	61.7	57.0	63.8	60.8

WILDLIFE NOTES

Skipjack tuna spend daylight hours in deep water near land, swim as far as 60 miles out to sea at dusk to spend the night in surface layers, and return to the coastal site at dawn.

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A mosquito can beat its wings at the rate of 300 times a minute.

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The skunk's artillery is capable of hitting its target at ranges of 5 to 10 feet and can be discharged 5 to 6 times in rapid succession.

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The California condor is America's largest soaring bird.

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An individual female of some dragonfly species lays up to 100,000 eggs, and there are 412 species in North America.

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A cow moose in Alaska was clocked at 33 mph for 6 miles during which its bursts of speed reached 45 mph.

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During the hatching period, the queen termite lays 60 eggs per minute or 80,000 in a single day, and while doing it grows in size from 2 to 5 inches.

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Chimney swifts perform their courtship and mating rituals while in flight.

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Despite such hardships as freezing off their ears, toes, and tails, opossums have survived their migrations north and are now common in New England.

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Of all the trout species, the brown is the heartiest. It can withstand more pollution than any of its cousins.

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Although its life span in the wild is not known, the trumpeter swan has lived 30 years in captivity.

•

Sea lillies only look like the plant for which they are named. They are really animals.

SURFICIAL GEOLOGY AND LAND-USE PROBLEMS

J. STEWART WILLIAMS, ALVIN R. SOUTHARD, and PAUL SUMMERS

As the urban sprawl of Utah's Wasatch Front communities creeps up the mountain fronts and into the back valleys of the Wasatch Mountains, consideration for that thin layer of loose earth material that overlies the bedrock underneath — the layer geologists prefer to call the regolith — will become increasingly important. We live on the regolith. The plants grow in this layer and draw water and nutrients from it. We build our dwellings, roads, bridges and almost all our structures on it. We till the topmost layer of it to produce the food supply, and finally our remains are buried in it. A convincing argument can be made for the proposition that this surface deposit, with its upper-most layer, the soil, is the most important layer or zone on the earth. As the world's population pressure requires a constantly intensifying use of land areas, particularly for the growth of towns and cities, a study of surficial geology becomes more and more important.

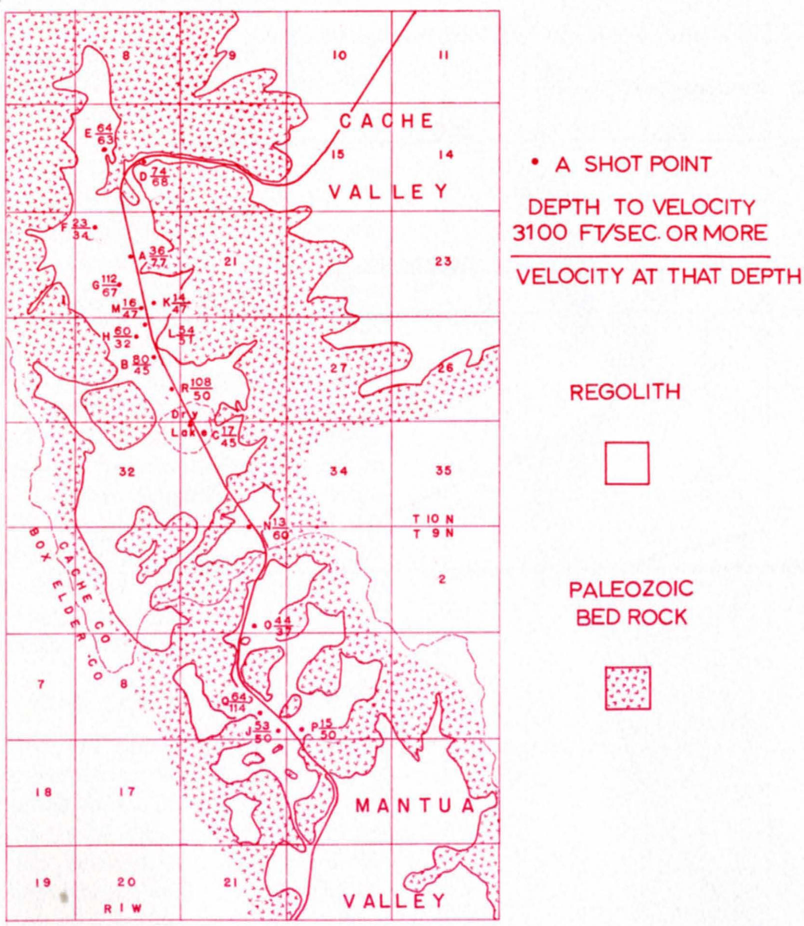

Figure 1. Map of the "back valley" between Cache and Mantua Valleys, and the route of highway 89-91. Locations and results of seismic probes are shown.

Its thickness, composition, and physical properties are of great importance to all of us, particularly those developing an area to support a new town or subdivision. When people become concentrated in a particular area, questions of what the regolith is like and how it must be utilized to bring about the desired objective in utilization become paramount.

How thick is the regolith and of what is it composed? Does it bear water and if so, can this water supply be utilized for culinary or agricultural purposes? Can this water become a threat to basements of houses and other structures in the regolith? How is it related to the problems of waste disposal in the area?

Is the regolith stable or subject to movement — creep, slide, or flow? Is it likely to move if disturbed by grading or cutting? Has it moved appreciably or rapidly in the past, and might it move in the future, particularly under the special conditions caused by severe earth shocks or unusual wettings? What will happen to the uppermost layers of the regolith when they are denuded of the natural vegetation and subjected to the overland runoff of surface water? Will they wash or gully under these conditions, or even perhaps blow away when subjected to strong winds?

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J. STEWART WILLIAMS is an Emeritus Professor in the Department of Geology. ALVIN R. SOUTHARD is an Associate Professor in the Department of Soils and Meteorology. PAUL SUMMERS is a former Graduate Student in the Department of Geology.

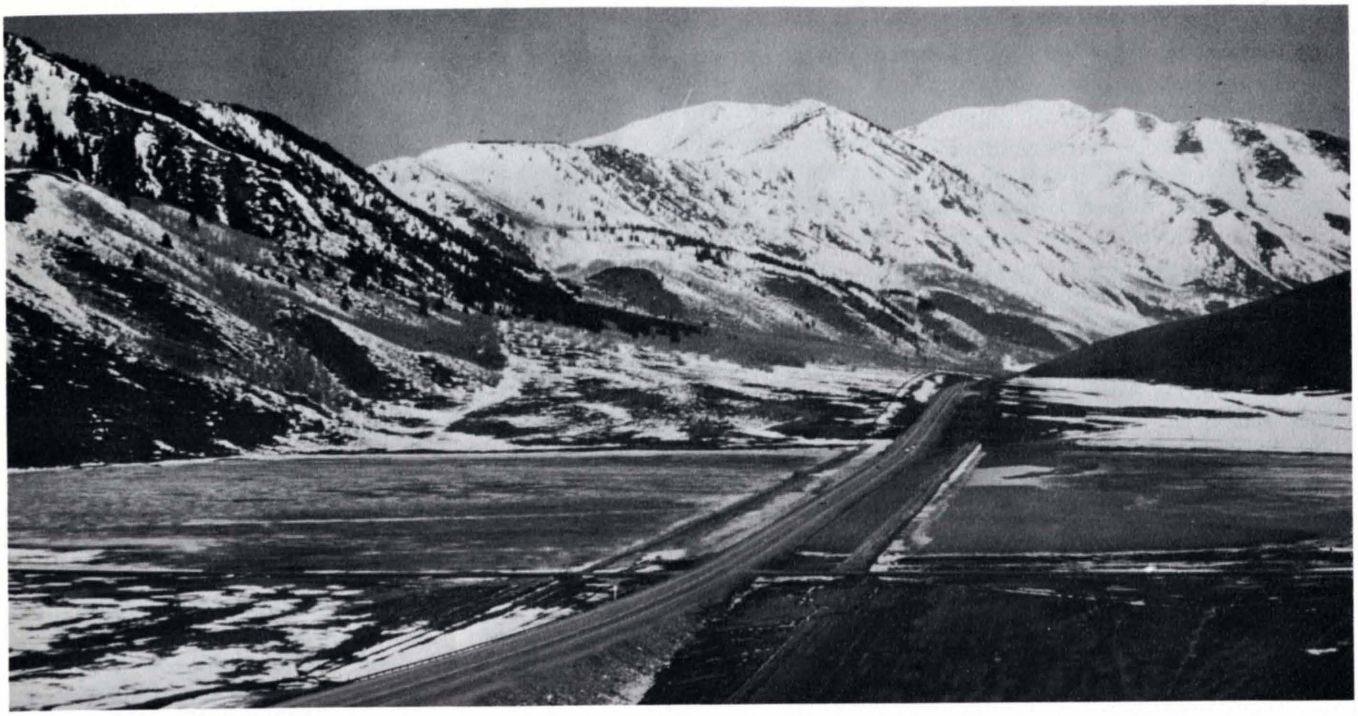

Figure 2. View northwestward across Dry Lake and the large alluvial fan north of it.

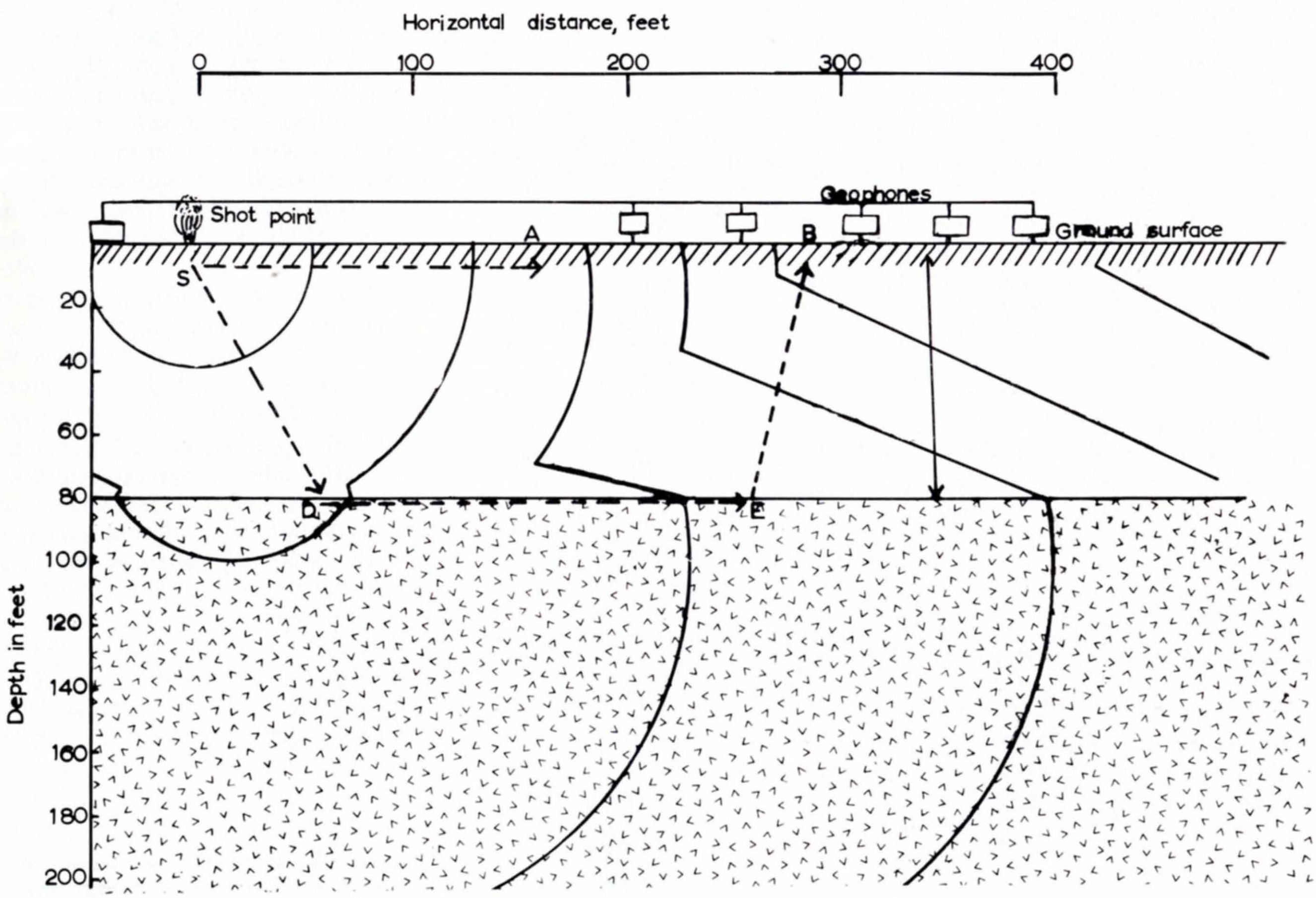

Figure 3. Diagram of the movement of shock waves through the regolith, and how they are measured by a portable seismograph.

These and many other important items of information are to be had by a study of the regolith or surface layer well in advance of the time when the critical answers must be provided.

The methodology employed to obtain critical data to answer such questions and the type of results achieved in a reconnaissance study of surficial geology is found in a recent report made by scientists from Utah State University. The typescript report entitled "Surficial Geology of the Pisgah Hills Area, Cache and Box Elder Counties, Utah" is on file with the Division of University Research. The study area is one of the most beautiful and well-known "back valleys" of the Wasatch Mountains — the Dry Lake area of north-central Utah which lies in Box Elder and Cache counties.

This particular "back valley" is a trench-like depression in the Wasatch Mountains between Box Elder Canyon east of Brigham City and Wellsville Canyon southwest of the town of Wellsville (figure 1). It might be called the Pisgah Trench. It trends nearly north-south, and is marked by the Dry Lake depresssion near its center (figure 2). U.S. Highway 89-91 traverses the trench from one end to the other enroute between the Wasatch Front and Cache Valley. The road from the town of Mantua northward follows up Dry Canyon to the Sardine Summit, then drops down through the Dry Lake depression and across a large alluvial fan built from the high Wasatch crest to the west, then exits from the trench through Wellsville Canyon.

HOW FAR TO BEDROCK?

Study of the surficial geology of any particular area begins with a determination of the extent and thickness of the regolith. Outcrops of the bedrock are rather readily distinguished, and aerial photographs of a region are an ideal base upon which to map the areas where regolith covers the bedrock. The extent of the covered areas is rather easily delimited (figure 1), but the problem of depth is much more difficult to solve.

The most direct and most conclusive method of determining the depth to bedrock through the cover of regolith is to dig or drill through it, but this method is very expensive and time-consuming. An indirect approach, using the elasticity and density of the earth materials that make up the regolith as determined by the way in which they transmit shock waves, is relatively cheap and rapid. The instrument to measure the velocity of the shock waves is a portable seismograph, and the shock is produced by a stick of dynamite exploded a few feet beneath the surface. The accompanying diagram (figure 3) shows how the shock waves spread along a string of geophones or seismometers connected to a recorder that measures small intervals of time very accurately. This equipment provides the data for a travel-time-distance curve, from which velocities may be read. The curve also reveals the depth to each layer of different velocity and from the velocity may be inferred the nature of the earth material.

Dry regolith has a velocity of about 2,000 feet per second. Saturated regolith has approximately double the velocity of the same material dry. So the position of the top of the zone of saturation, the

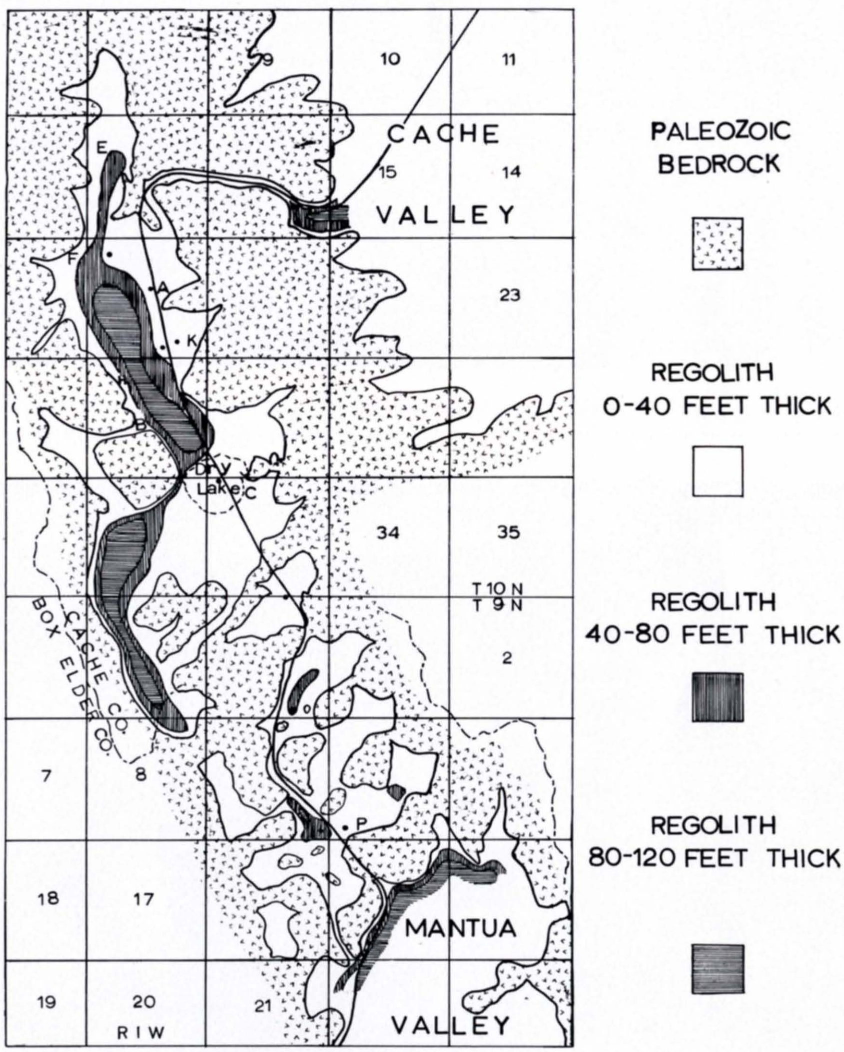

Figure 4. A map of the study area showing bedrock areas and thickness of regolith.

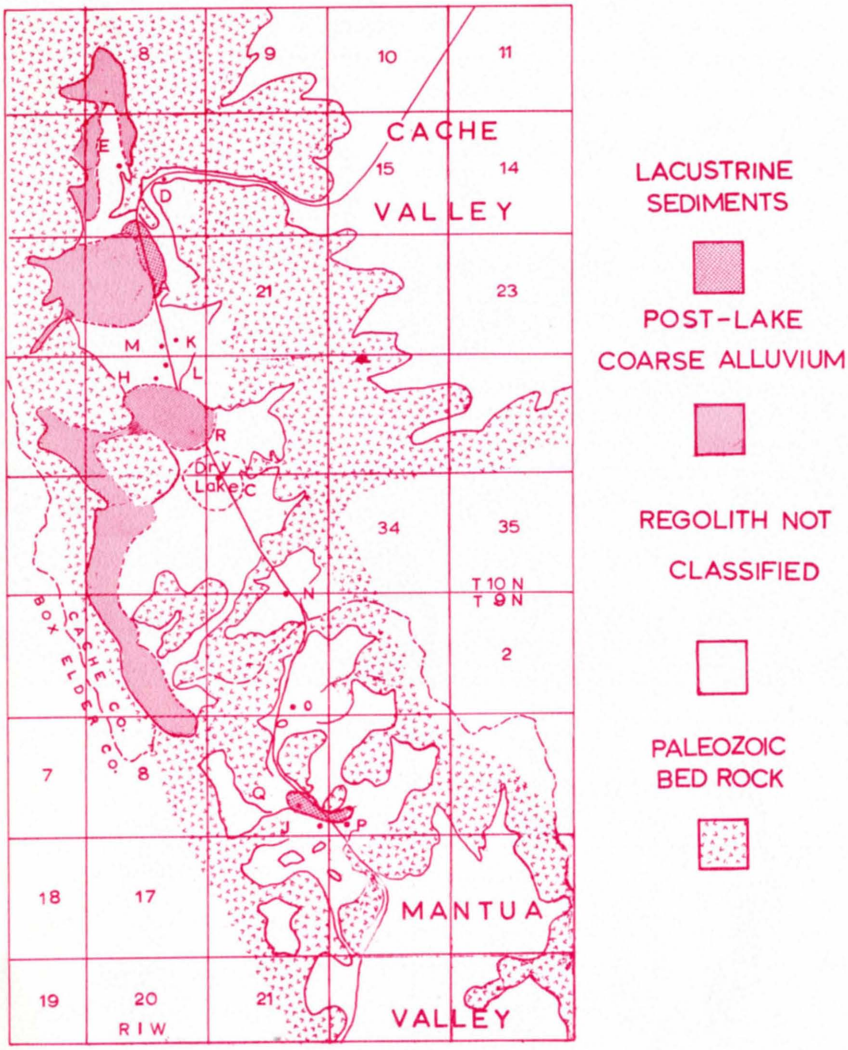

Figure 5. Map showing the areas covered by lake beds, and coarse alluvium younger than the lake beds.

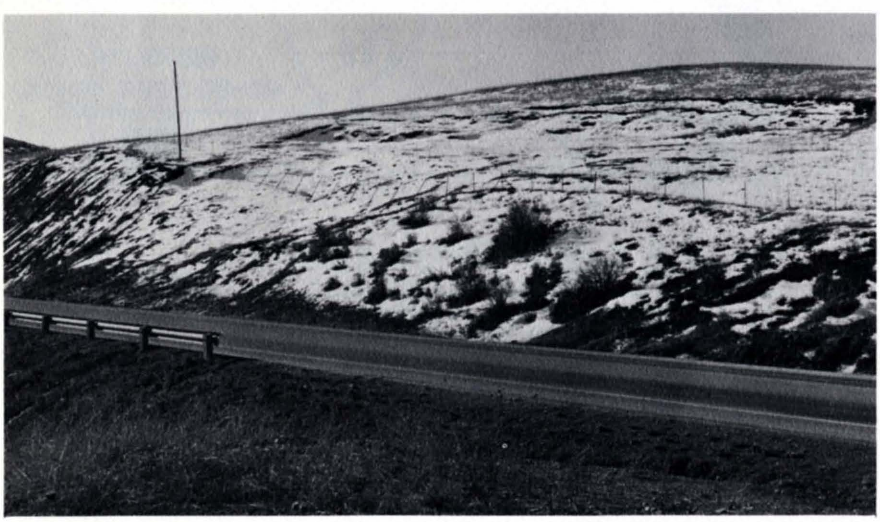

Figure 6. Earthflow in lake beds induced by meltwater from the winter's snow pack.

water table, is revealed. Sound, unbroken bedrock will have a velocity near or greater than 10,000 feet per second; weathered and broken bedrock, values in between.

Figure 1 shows the results of 17 seismic probes over the area. The shot points are designated with a letter, and the adjacent figures give the depth to material with a velocity greater than 3,100 feet per second over the velocity at the depth in hundreds of feet per second. Consideration of the local geology led us to believe that a velocity of 3,100 feet per second indicated weathered bedrock. Figure 4 is a map showing depth of bedrock in the area based on the data in figure 1. It shows that over most of the area the depth is less than 40 feet, but in the areas adjacent to the high western ridge, it increases to over 120 feet. Underneath Dry Lake it is less than 40 feet.

WHAT IS THE REGOLITH LIKE?

The thin regolith in the Pisgah Trench is principally of two kinds; fine-grained deposits of silt and clay, most of which have accumulated in a lake or lakes; and coarse-grained gravely material brought by small streams from the ridges surrounding the trench, particularly on the west side.

The lacustrine sediments are well bedded, are brown or gray in color, and some have abundant snail and clam shells, remnants of the animals that inhabited the lake. Incidentally, the lake beds in this study area are several hundred feet above the shorelines of Lake Bonneville, and were not deposited in that well-known ancient lake.

The time when the lakes existed was followed by a period when the streams from the high western ridge brought abundant coarse material and built alluvial fans down over the lake beds (figure 5). The large alluvial fan north of Dry Lake is the best example (figure 2) — an easy-to-be-seen deposit of these gravels.

Since these two episodes of deposition, erosion by the streams toward both Cache Valley and Mantua Valley have removed much of both the lake beds and the overlying gravels.

WATER SUPPLY

In a general way, the relatively thin regolith in the small valleys and basins of the study area stands "high and dry" above Mantua and Cache valleys. It is too thin to contain much water if it were saturated, and it lies generally on porous limestones that permit the water to drain through to deep channels that probably drain into the deep adjacent valleys. Where the bedrock is not porous, it forces the water to the surface, creating such springs as those in Wellsville Canyon. The 20 feet or more of silt and clay beneath Dry Lake keeps the water of the lake perched there until it evaporates. Some of it may migrate beneath the alluvial fan to the north and appear in the Wellsville Canyon springs.

If and when the small but beautiful basins and valleys of the Pisgah Trench become inhabited, waste disposal will be an immediate problem. With the circulation system described above, springs in Wellsville Canyon and even those nearby in Cache Valley and Mantua Valley would be in danger of contamination from waste deposited in the study area.

DOES THE REGOLITH MOVE?

When the fine-grained former lake beds of the area become saturated, as when the snowpack melts in the spring, they flow readily, creating highway maintenance problems (figures 6 and 7). When they are denuded of vegetation, they wash readily showing a pattern of shoestring gullies (figure 9). On the higher surfaces, a thin layer of silt, that may have been wind-blown in the first place, might move again if it were cleared of vegetation and thoroughly dried (figure 8).

Development of the lake bed areas will, then, require careful management. It will be necessary to keep them as well drained as possible, prevent the creation of overly steep cut-faces or banks, and protect them from overland runoff of water; otherwise they will flow, gully, or blow.

In contrast, the gravel areas are well drained, particularly where the deposits have considerable thickness, as on the western side of the trench, and should not be bothered with drainage or foundation problems. Here, however, the regolith is rather coarse, presenting a different type of problem to the developer, home owner, or gardener. The difficulties now are those of moving overly large boulders and clearing areas of larger rocks to permit lawns and gardens. Also, here, there is the geologic hazard of an extremely heavy rainfall on the mountain face to the west, with an accompanying flow of mud

Figure 7. Lake beds near north end of Pisgah Trench. Road is protected from earth flows by gravel barricade.

Figure 8. Layer of silt, probably wind-blown on bedrock. Sardine Summit.

and rocks from one or more of the steep canyons.

SURFICIAL GEOLOGY STUDY WORTHWHILE

This brief review of a reconnaissance study of a readily accessible area between valleys that are already well populated, and from which the urban sprawl may reach, should indicate that valuable information related to urban development is to be had for a relatively small investment in time and money, particularly if the emphasis is directed to that thin but mobile layer, the regolith.

The study briefly reported here was done on a small research budget, utilizing Utah State University staff and equipment and a backlog of geological and pedological information gathered over years by the staff members. Approximately 15 square miles were covered and the actual outlay in an operating research budget was ridiculously small. Had the work been done by hired consultants available locally, it might have cost \$300 to \$400 per square mile. The more intense the coverage, the greater the cost per unit area; and in an intensive study of a smaller area, the cost could well reach \$1,000 per square mile.

But, hopefully, the point has been made that this type of information may become very useful in solving land use problems and, as its usefulness increases, the cost of the information becomes a very attractive investment.

Figure 9. Gullying of exposed lake beds on an abandoned road cut.

Figure 10. Gullying due to the escape of subsurface water, probably aided by trampling animals.

THREE KEYS TO PESTICIDE SAFETY

READ THE LABEL ON EACH PESTICIDE CONTAINER BEFORE EACH USE. Follow instructions; heed all cautions and warnings. Why read the label each time? Because the chemical nature of pesticides and their uses vary greatly. You should refresh your mind each time on the material's specific uses.

APPLY PESTICIDES ONLY AS DIRECTED. Apply them only to the crops specified, in amounts specified and at times specified in label instructions, or by your agricultural authorities.

DISPOSE OF EMPTY CONTAINERS SAFELY. It is almost impossible to remove all material from a container. "Empty" containers contain small amounts of pesticides which could harm children or animals who might get into them. It is best to dispose of empty containers by burying them at least 18 inches deep in an isolated area provided for this purpose away from water supplies.

Hints for profitable silage making

M. J. ANDERSON and J. J. BARNARD

Many livestock producers in Utah have changed to a silage system for the feeding of their animals, and numerous others are asking if this is a more profitable way of handling forages.

The use of a silage system is not likely to increase animal performance over good quality hay. However, good quality silage can frequently be produced when harvesting of hay is not possible. Under these conditions, more feed can be preserved per acre. If proper procedures are followed, a 10 to 15-percent increase in forage can be obtained. Another advantage of silage is the ability to implement a complete feeding program in which grain and supplements are mixed with the silage and only one type of feed is offered to the animals. In addition, a silage system lends itself to more mechanization than baled hay in both harvesting and feeding operations, thereby minimizing the labor problem.

COMPARISON OF HAY AND SILAGES

If forage is cut the same date and harvested under conditions favorable to wilted silage (60 to 70% moisture), low-moisture silage (40 to 60% moisture), or hay, very little difference in performance of the animals is usually observed. The animals will eat approximately the same weight of dry matter and produce the same amount of milk. The results of a study conducted at the University of Illinois is fairly typical of the results that are obtained when hay, silage, and haylage are fed to dairy cows (table 1). Similar results would be expected from beef or sheep.

SILAGE SUMMARY

1. Animals can be expected to produce equally well from hay, wilted silage, or low-moisture silage of equal quality.
2. A silage system has the advantages of producing more feed per acre, mechanization of harvesting and feeding, producing high quality feed when weather conditions prevent making hay, and the mixing of grains and supplements with silage for a one-ration feed.
3. Proper procedures must be followed in producing good silage. The forage should be wilted, the silo filled rapidly, packing should be thorough, and an air-tight cover used. The silo should be the proper size for the loading and feeding operations.
4. Silage preservatives are not needed for making good silage if proper procedures are followed.
5. If proper procedures are not followed, disastrous results can be expected. Preservatives and gas-tight silos will not compensate for poor management practices.
6. The most efficient moisture content for silage making is between 60 and 70-percent moisture. However, for gas-tight silos, the moisture content is not as critical and a slightly lower moisture content might be advisable.
7. Heat damage occurs when forage is too dry or improperly packed or if the silo is not filled rapidly. This results in forage with low digestible protein and energy and a total loss of vitamin A.

PROPER ENSILING PROCEDURES

The silage fed can be no better than the forage going into the silo. Forage must be harvested at the proper stage of maturity to obtain the maximum in milk or meat per acre. The forage should be cut when it is high in nutritive value and when yields are highest. Alfalfa should be cut at the bud to one-tenth-bloom stage.

Silage preservation is dependent upon the absence of atmospheric oxygen. This results in the breakdown of carbohydrates by bacteria to lactic and volatile fatty acids. When the acids reach a certain concentration, the bacteria are killed by the acids and no further breakdown occurs. When air is present, mold growth and/or excessive heating occur. In both situations, excessive losses of nutrients occur that could have been utilized by the animals. In direct cut silage, the failure to achieve low enough pH will result in a fermentation shift. Butyric acid production takes over and protein degradation proceeds to ammoniacal nitrogen and thus results in low grade silage which is not readily accepted by animals.

To rapidly exclude air, follow the recommended procedures for packing, filling, and covering of conventional type silos. Gas-tight silos are excellent, but excellent silage also

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Figure 1. Unloading and packing corn silage in a butyl-lined fence bunk silo.

Figure 2. After packing, the silo was covered with butyl and old tires were tied together and laid across the top.

Figure 3. Opening up the bunk silo and loading silage onto the feed truck.

can be produced in bunker or pit-silos.

A silo should be planned which facilitates harvesting and feeding and also maintains the quality of feed. Proper silo size is important. Silos that are too small are expensive and inefficient. However, a silo that is too large will not be filled rapidly enough, resulting in heat damage.

In the filling of any silo, the operation should move as rapidly as possible. Delays will result in a layer on the top that heats. This problem also may occur in gas-tight silos because the silo is open during the filling operation and no attempt is made to pack the forage. In bunker and trench silos it is especially important that the forage be well packed to exclude the oxygen and allow the proper type of fermentation. Failure to properly pack will result in poor quality feed.

The proper use of a good plastic cover will usually result in the saving of enough feed to more than pay for its cost. A 6-mil plastic is usually recommended. The cover should be securely held down so that it is in contact with the silage. Unless the cover is properly secured, it will not prove of much value and the cost of the plastic is wasted.

When feeding starts it is desirable to remove about 6 inches of silage from the face of horizontal silos. In hot weather, removal of silage from the complete face of the silo should occur daily. In cool weather, it may only be necessary to move across the face of the silo every third day.

WILTING VERSUS PRESERVATIVES

Many of the silage preservatives currentliy being marketed are not reliable for making good silage with direct cut procedures. If a silage preservative is to be used, it should be one that has been scientifically tested. Grains and feed by-products such as beet pulp are effective as preservatives if used in sufficient amounts to reduce the moisture content and provide readily fermentable carbohydrates. Formic acid has proven to be effective in silage preservation and to increase the value of the feed. However, formic acid is dangerous to handle and at the present time the increased value in conserved nutrients does not justify the expense. It is possible that the cost of formic acid will be reduced considerably in the future.

Wilting is the most economical method of producing good silage. It should be remembered that good silage can be produced if forage is wilted to 60 to 70-percent moisture, precautions are taken to insure proper packing, the silo is filled rapidly, and a good cover is used.

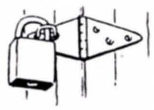
MOISTURE CONTENT OF SILAGE

Considerable research work has been done on the amount of moisture in silage at the time of harvest. In general, it has been found that when forage is direct-cut and/or contains more than 70-percent moisture, the resulting silage is unpalatable and has an offensive odor even when preservations have been used. In addition, seepage, fermentation, and spoilage losses are considerably higher than if the forage is wilted before ensiling.

Wilting of forage to 60 to 70-percent moisture has been found to be the most efficient means of preserving feed even with a gas-tight silo. Less total loss occurs at this level of moisture than when the forage is dryer or wetter. In the case of sealed storage, however, forage can probably be dryer than for a pit or bunker and still be properly preserved. However, the possibility of heat damage at low moisture levels exists. This fact should be considered in the decision for low moisture silage even though the loading and unloading mechanisms work better when less moisture is present. At 60 to 70-percent moisture the forage packs well and oxygen is excluded thus insuring proper fermentation action. With good management practices, the losses shown in table 2 are typical from ensiling in conventional and sealed storage silos at various moisture levels. The efficiency of total dry matter available to feed is compared to hay.

HEAT DAMAGE EFFECTS

Silage will heat and a browning reaction take place when it is too dry to properly pack. This results in a total loss of vitamin A, a decline in digestible energy and digestible protein. The animals may readily consume the silage, but the nutritive value of the feed is not sufficient for high production. Supplementation with vitamin A, protein, and additional grain is necessary to obtain the same level of animal performance as from undamaged silage. Frequently, spoilage occurs with resultant digestive upsets among the animals or there is a total loss of the forage. Besides the loss of nutrients and sickness, additional labor is required to dispose of the spoiled material.



STORE PESTICIDES IN THEIR ORIGINAL, LABELED CONTAINERS. Keep them out of the reach of children and irresponsible people. They cannot be properly identified unless they are in original labeled containers. Lock pesticides in a shed away from feed, seed, and other farm supplies.

Table 1. A comparison of the feeding value of hay, silage, and low-moisture silage as feeds for dairy cows*

Item	Hay	Silage (wilted)	Low-moisture Silages
Moisture content (%) (stored)	13.6	66.2	49.5
Dry matter consumption (lbs/cow/day)			
forage	26.2	23.7	24.6
grain	13.8	13.6	13.5
Total	40.0	37.3	38.1
Milk (FCM, lbs/cow/day)	47.2	44.3	46.1
Ratio grain: FCM	3.01	2.87	3.00
FCM/lb dry matter consumed	1.18	1.19	1.27
Digestibility of organic matter (%)	72.8	67.9	71.8

* Source: J. Dairy Sci. 48:206, 1965

Table 2. Relative losses and value of hay crop silages compared to hay for yield of dry matter based on a 100 tons potential for hay*

Forage moisture	Avg field losses (%)	Net tons DM stored	Avg storage loss (%)	Net DM for feeding (tons)	Efficiency
70% or higher	2	98	23	75	99
60 to 70%					
conventional silo	5	95	12	84	111
gas-tight silo	5	95	6	89	117
55% moisture					
conventional silo	8	92	12	81	107
gas-tight silo	8	92	4	88	116
50% moisture					
gas-tight silo	10	90	3	87	115
40% moisture					
gas-tight silo	13	87	2	85	112
hay					
(good conditions)	20	80	5	76	100

* Source: Silo News, Winter 1967

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BRIDGERLAND — NEW RED WINTER WHEAT

(Continued from Page 22)

Intermountain region. Its superiority over Cache in breadmaking quality can be seen from the comparisons in table 2. Two of the most important quality characteristics are mixing stability and loaf volume. The mixing tolerance or stability of flour is an important factor in the highly mechanized breadmaking process. Bridger's mixing stability is frequently 2 to 3 times that of Cache. It also exceeds Cache in loaf volume and in other desirable loaf characteristics such as crumb color and texture. Test weight (weight per bushel) is another quality characteristic in which Bridger excels. Its relatively compact kernel usually gives it a pound or two advantage over larger kerneled varieties such as Delmar (table 3).

YIELD PERFORMANCE

With regard to yield, Bridger appears to be about average for the dryland varieties grown in this area. Its performance in state and regional yield trials over the past several years is summarized in table 4.

Approximately 75 acres were planted from Foundation seed stocks in the fall of 1969. Assuming normal winter survival and average yields, from 2,000 to 2,500 bushels of the new variety should be available for fall seeding in 1970.

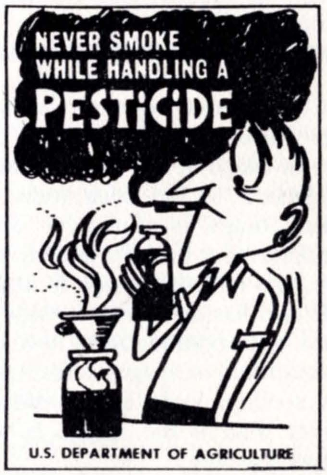

Table 4. Comparative yields of Bridger and several of the leading dryland winter wheat varieties grown in the Intermountain area

	Utah trials				Western Regional Trials*	
Variety	1967 (4 locations)	1968 (2 locations)	1969 (3 locations)	3 year avg (9 locations)	1968 (13 locations)	1969 (17 locations)
	bushels per acre					
Bridger	41.9	38.5	34.9	38.8	48.9	46.9
Cache	39.2	35.5	33.3	36.4	------	------
Delmar	41.0	34.8	33.6	37.2	48.9	46.0
Itana	42.3	41.5	36.5	40.2	47.2	44.0
Itana 65	41.0	39.5	36.0	39.0	46.7	47.9
Tendoy	42.2	38.0	36.6	39.4	48.5	44.0
Wanser	41.2	37.9	38.8	39.5	55.0	44.7

* The Western Regional data were taken, by permission, from the USDA HRW regional reports. Data for these reports are contributed by state and federal workers in Washington, Oregon, Idaho, Montana, Colorado, and Utah.